TENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1917-1918

SUPPLEMENT TO THE REPORT OF
THE DEPARTMENT OF AGRICULTURE

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To the Honourable J. E. Caron, M.P.P.,
Minister of Agriculture,
Quebec.

Sir:—

I have the honour to present herewith the Tenth Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 21st of March, 1918.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

J. M. SWAINE,
Secretary-Treasurer.

Ottawa, 1918.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

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President—Professor W. Lochhead, Macdonald College.

Vice-President—Rev. Father Leopold, Oka Agricultural Institute, La Trappe, Que.

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Dr. D. W. Hamilton, Macdonald College.

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Delegates to the Ontario Entomological Society—Dr. J. C. Chapais, St. Denis, Que., and Father Leopold, La Trappe.

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Bunting, Prof. T. G.....Macdonald College
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Chagnon, G.....P.O. Box 521, Montreal
Chapais, J. C.....St. Denis-en-bas, Que.
Chrystal, R. N.....Entomological Branch, Dept. of Agr., Ottawa
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Cloutier, H.....La Trappe, Que.
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Eastham, J. W.....Vernon, B.C.
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Fyles, Rev. Dr. Thos. W.....368 Frank St., Ottawa
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Gibson, Arthur.....Entomological Branch, Dept. of Agr., Ottawa
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Gooderham, C. B.....C.E.F., Dept. of Agr., Ottawa
Gorham, A. C.....Macdonald College
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Guenette, L.....Forest Service, Quebec
Gussow, H. T.....C.E.F., Dept. of Agr., Ottawa
Hall, G. H.....672 Durocher St., Montreal
Hall, Landon.....Cowansville, Que.
Hamilton, Dr. D. W.....Macdonald College
Hammond, H. S.....Macdonald College
Hewitt, Dr. C. G.....Entomological, Branch Dept. of Agr., Ottawa
Holmes, J. G.....4610 St. Catherine St., Westmount
Honore, Rev. Father.....La Trappe, Que.
Hutchings, C. B.....Entomological Branch, Dept. of Agr., Ottawa
Jack, Norman E.....Chateauguay Basin, Que.
Jackson, Dr. F.S.....108 Park Ave., Montreal
Jenkins, M. H.....Ottawa, Ont.
Keating, Rev. Prof.....Loyola College, Montreal
Kieffer, H. F.....Forest Service, Quebec
Lavoie, J. H.....Agricultural Bureau, Quebec
Leopold, Rev. Father.....La Trappe, Que.
Levasseur, Rev. Paul.....Ste. Anne de la Pocatière
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MacClement, Dr. W. T.....Queen's University, Kingston, Ont.
Maheux, G.....Provincial Entomologist, Que.
McCubbin, W. A.....St. Catherines, Ont.
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McMahon, E. A.....Macdonald College
McOuat, J. E.....Macdonald College
Menard, J. H.....Forestry School, Berthierville
Moore, G. A.....359 Querbes Ave., Outremont
Murray Prof. James.....Macdonald College
Nagant, H.....Quebec

Newton, Margaret.....Senneville, Que.
Nolet, Louis.....College de Levis, Levis, Que.
Pasquet, Jos.....Ste. Anne de la Pocatière
Petraz, Mr.....Hortic. Service, Que.
Piché, G. C.....Chief Forester, Quebec
Reid, Peter.....Chateauguay Basin, Que.
Reynaud, Mr.....Berthierville, Que.
Roy, H.....Forest Service, Quebec
Roy, H. B.....Sudbury, Ont.
Stanford, P. Clayton.....Dartmouth, N.S.
Savoie, Narcisse.....Dept. of Agr., Quebec
Simard, J.....Dept. of Agr., Quebec
Southee, G. A.....356 Durocher St, Outremont
Strickland, E. H.....Dept. of Agr., Ottawa
Summerby, R.....Macdonald College
Swaine, J. M.....Entomological Branch, Dept. of Agr., Ottawa
Tessier, G.....Forest Service, Quebec
Vanderleck, J.....Macdonald College
Victorin, Rev. Bro.....Longueuil, Que.
Willey, Prof. A.....58 Metcalfe St., Montreal
Winn, A. F.....32 Springfield Ave., Westmount

HONORARY MEMBERS

James W. Robertson, Esq., LL.D., C.M.G., Ottawa.
Hon. J. E. Caron, M.P.P., Quebec.
Hon. Jules Allard, M.P.P., Quebec.
F. C. Harrison, D.Sc., Macdonald College.
Rev. Canon Huard, D.Sc., Quebec.
Rev. Father Superior, La Trappe.
Rev. Father Superior, Ste. Anne de la Pocatière.
Auguste Dupuis, Village des Aulnaies.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES, 1917-1918

Receipts

Brought forward	$201.11
Provincial Government Cheque	250.00
Interest on Deposit	7.58
	$458.69

Disbursements

Expenses of Members and Lecturers to Winter Meeting	$69.97
Expenses of Delegates to Ontario Entomological Society	25.00
Investigations in Insects and Fungi, Expenses	30.00
Office Assistance	20.00
Express and Postage	14.05
Secretary	50.00
	$209.02
Balance in Bank, March 20, 1918	249.67
	$458.69

For Auditor:

ARTHUR GIBSON

J. M. SWAINE, Secretary-Treasurer

WM. LOCHHEAD, President.

REPORT OF THE SUMMER MEETING

The summer meeting of the Quebec Society for the Protection of Plants was held October 4th and 5th, 1917 at the Berthierville nurseries. The plan was to make the meeting a field meeting with the double purpose of studying the insect and fungous pests of the nursery trees, and of becoming acquainted with the work done at the nurseries. Unfortunately, however, rain prevented the full inspection of the plantations, and only two hours were spent outdoors. The remaining time was profitably spent indoors in listening to addresses by Mr. G. C. Piché, Chief of the Forestry Service in general charge of the nurseries, by J. H. Lavoie, Chief of the Horticultural Service, by Mr. Swaine, Mr. Winn and Prof. Lochhead.

The meeting was held in the Forestry School, where the visitors were royally entertained by Mr. Piché and his assistants.

Among those present were G. E. Piché, J. H. Lavoie, G. Maheux, S. Roy, Henri Roy, G. Tessier, H. F. Kieffer, J. H. Menard, Mr. Cloutier, Mr. Petraz, Mr. Renaud, J. M. Swaine, A. F. Winn, C. B. Hutchings, F. E. Buck, W. Lochhead.

REPORT OF THE WINTER MEETING.

The tenth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College, on Thursday, March 21st, 1918.

Business Meeting.

At 2.15 p.m. the business meeting was opened by the President. There were present Dr. Harrison, Prof. W. Lochhead, Dr. Chapais, G. Maheux, Provincial Entomologist; Father Leopold, Professor Letourneau and Bro. Benjamin of the Oka Agricultural Institute; Messrs. Roy, Bedard and Ménard of the Forestry Branch, Quebec; Dr. C. Gordon Hewitt and Dr. Cameron, of the Dominion Entomological Branch; Rev. Dr. Campbell, A. F. Winn, Lachlan Gibb and R. F. Cummings of the Montreal Branch; Peter Reid, Secretary of the Quebec Pomological Society; Prof. W. P. Fraser, P. I. Bryce, Prof. Murray, Prof. Bunting, Dr. Hamilton, R. Summerby, A. C. Gorham, E. M. Ricker, E. A. Lods, J. C. Moynan, and several students of Macdonald College.

Minutes of the last meeting on March 23rd, 1917, as given in the Ninth Annual Report, were approved.

Report of the Treasurer was read and accepted.

The following officers were elected for the ensuing year:—

PRESIDENT—Professor W. Lochhead, Macdonald College.

VICE-PRESIDENT—Rev. Father Leopold, La Trappe.

SECRETARY-TREASURER—J. M. Swaine, Assistant Entomologist for Forest Insects, Ottawa.

CURATOR AND LIBRARIAN—P. I. Bryce, Assistant in Biology, Macdonald College.

DIRECTORS—Rev. Dr. Thomas Fyles, Ottawa; Prof. Letourneau, La Trappe; Rev. Bro. Victorin, Longueuil; A. F. Winn, Montreal; Rev. Prof. Fontanel, Montreal; G. Maheux, Provincial Entomologist, Quebec; G. Chagnon, Montreal; Prof. W. P. Fraser, Macdonald College; Professor G. Bouchard, Ste. Anne de la Pocatière.

AUDITORS—E. M. DuPorte, Dr. D. W. Hamilton, Macdonald College.

DELEGATE TO THE ROYAL SOCIETY OF CANADA—Professor W. Lochhead.

DELEGATES TO THE ONTARIO ENTOMOLOGICAL SOCIETY—Father Leopold, Dr. Chapais.

ALTERNATIVE—Professor Letourneau.

The usual grants from the funds of the Society for expenses in connection with special investigations of insect and fungous diseases in the province were continued for another year.

Mr. Winn reported that Mr. Moore would in all likelihood present Part IV of the List of Insects of the Province of Quebec—the Hemiptera, during the coming year.

It was decided to hold the summer meeting at a place to be selected later by the President and Secretary.

Mr. Auguste Dupuis, Director of Fruit Experiment Station, Village des Aulnaies, who has been Vice-President of the Society since its organization, was made an *honorary member* of the Society.

The Society decided to grant the sum of five dollars in aid of the memorial tablet in honor of Provancher at Cap Rouge.

A committee of three, the President, Dr. Chapais and Mr. Maheux, was appointed to deal with the matter of a memorial tablet to Provancher to be placed in the Provincial Museum, Quebec.

GENERAL SESSION.

The general session of the Tenth Annual Meeting was opened at 3.15 p.m. by the President, Prof. W. Lochhead.

Principal Harrison in his address of welcome congratulated the Society on its good work during the ten years of its existence. He emphasized the need for more trained men in Canada to cope with crop pests, and hoped that the time was not far distant when scholarships would be available for graduate students of agricultural colleges who desired to study an additional year along special lines.

The address of the President was a resumé of the work of the Society during the ten years of its existence, and of the advances made in America along the lines of economic entomology and plant pathology.

Prof. W. P. Fraser gave an interesting and instructive address on the "Fungous Pests of Cereal Crops," dealing specially with the Smuts and Rusts. He pointed out clearly that while most of the Smuts could be controlled by treating the seed grain with formalin, no adequate method of controlling the Rusts had as yet been discovered, although certain measures would alleviate conditions.

Dr. J. C. Chapais read an interesting paper on the White-marked Tussock Moth which was prevalent in many sections last year and threatens to become destructive this summer.

Father Leopold, in a short address, made two valuable suggestions as to how the Society may help the fruit grower. These were the publication of a Calendar of spraying operations for Quebec orchards, and a committee to investigate spraying problems.

Dr. Cameron's address on "Bot and Warble Flies, their Habits and Control" was greatly appreciated. By means of lantern slides he showed the habits and the various stages in the life-history of the Bot and Warble Flies that trouble horses and cattle.

Mr. H. Roy's paper on "The Present Status of the White Pine Blister Rust in Quebec" described clearly the work done by the inspectors under the charge of the Forestry Branch in determining the distribution of this disease in Quebec.

Lack of time prevented the presentation of the papers prepared by Canon Huard, Prof. Adams, A. F. Winn, Father Fontanel, and P. I. Bryce.

The evening session was devoted to a Symposium of the subject "Greater Crop Production" from the standpoint of the Society. Prof. Lochhead dealt with the question: How may the Society help in greater crop production? He pointed out that the members, if organized and utilized by the Government,

could be of considerable service, in locating and controlling outbreaks of pests. Dr. Hewitt discussed the topic "Crop Protection as a Factor in Increased Crop Production" and described at considerable length the various means that could be adopted for the control of insect pests.

Mr. G. Maheux's address followed along similar lines, and described the plan of operation the Quebec Department had devised for the control of insect and fungous enemies of crops.

Mr. Peter Reid, Prof. Murray and Dr. Cameron also spoke.

The meeting closed at 9.45 p.m.

CORRECTIONS TO THE PRELIMINARY LIST OF THE COLEOPTERA OF THE PROVINCE OF QUEBEC.

Mr. H. C. Fall, of Pasadena, California, has kindly brought to the attention of the compiler of the Preliminary List of Quebec Coleoptera a few species which he classes as "impossible or questionable" residents of the province of Quebec. It is my duty to make these errors known, and I will ask all concerned to make the necessary changes in their copy of the above list.

Of the doubtful species mentioned in the list the compiler is responsible for the identification of three species, Viz.: *Rhantus calidus*, *Hyperaspis fimbriolata*, and *Pachybrachys viduatus;* the others are records obtained from other coleopterists.

The lists of the doubtful species as pointed out by Mr. Fall are:

Bembidium littarale Oliv.—Identified by Roland Hayward. Mr Fall says of this species: "I have doubts about this European species occurring anywhere in our fauna."

Callida decora Fabr.—Recorded by Charles Stevenson. Probably *punctata* but name of *decora* must have been given in error.

Hydroporus vilis Lec.—Record from Bro. C. J. Ouelette.

Rhantus calidus Fabr.—Wrong determination.

Falagria laeviuscula Lec.—Recorded by J. I. Beaulne.

Pontomalota opaca Lec.—Recorded by J. I. Beaulne.

Aleochara sulcicollis Mann.—Recorded by J. I. Beaulne.

Staphylinus saphyrinus Lec.—Recorded by J. I. Beaulne.

Philonthus occidentalis Horn—Recorded by J. I. Beaulne.

Cafius canescens Makl.—Recorded by J. I. Beaulne.

Xantholinus picipennis Lec.—Recorded by J. I. Beaulne.

Lathrobium jacobinum Lec.—Recorded by J. I. Beaulne.

Paederus compotens Lec.—Recorded by J. I. Beaulne.

Bledius armatus Er.—Recorded by J. I. Beaulne.

Bledius laticollis Lec.—Recorded by J. I. Beaulne.

Stenus sculptilis Casey—Recorded by J. I. Beaulne.

Stenus pinguis Casey—Recorded by J. I. Beaulne.

Phalacrus ovalis Lec.—Recorded from Bro. C. J. Ouellette.

Hyperaspis fimbriolata Melsh.—Wrong determination.

Omosita discoidea Fabr.—Recorded by several coleopterists. Determination evidently wrong.

Malachius ulkei Horn—Record from Bro. C. J. Ouellette.

Pachybrachys viduatus Fabr.—Wrong determination. This species is also mentioned in H. F. Wickham's papers on the Coleoptera of Ontario and Quebec (Can. Ent. XXVIII, page 156).

Mr. Beaulne states in reference to the above *Staphylinids* that mostly all were taken in greenhouses and that there is a possibility of their having been introduced from the Western States with nursery stock. It is also pointed out by Mr. Fall that the descriptions of many of Fauvel's species of *Staphylinidae* have never been published. It is therefore thought advisable to strike off for the time being the following species:

Gyrophaena affinis Fauv.

Placusa tricuspis Fauv.

Tachyusa modesta Fauv.

Atheta antennaria Fauv.

Atheta curticornia Fauv.

Atheta dimidiats Fauv.

Atheta hornii Fauv.

Oxypoda abbreviata Fauv.

G. CHAGNON.

PRESIDENT'S ADDRESS.

The Protection of Plants.

Our Society has now been in existence for ten years. Organized in 1907 with the cordial support of the Department of Agriculture of this province, it has carried on, without flourish of trumpets, a work whose scope is well described by the full title of the Society—*The Quebec Society for the Protection of Plants from Insects and Fungous Diseases.* At this decennial meeting it seems to me a fit and proper time and place to review not only the work of our Society but also the progress of economic biology during the past ten years.

Our Society was organized with two or three definite objects in view: First, it hoped to bring together annually the biological workers in the province who are interested in the study of economic entomology and fungi. It is a well-known fact that much inspiration, encouragement and help are gained at such meetings where workers have an opportunity of listening to papers and talking over matters of common interest. New viewpoints are presented, valuable information is frequently obtained, concerted action and mutual help are more likely secured, and fresh enthusiasm is aroused. While our active membership is not large, we feel that our meetings have been exceedingly helpful in many ways. Personally, I have been greatly benefitted by the association with my fellow members from all parts of the province, and I value very highly the new friendships that have been formed with my French-Canadian co-workers.

Second, the Society desired to spread abroad among the people the new gospel of insect and plant disease control so that larger crops might be harvested and greater profits secured by the farmer. That there was an urgent need for such a propaganda is evident from the large annual losses from the attacks of insects and fungi, which could have been prevented to a larger extent. For example, smut causes annually a loss to the oat crop of Quebec of over two million dollars; "blights" to the potato crop of over three millions and perhaps very much more; "spots" to the bean crop of over two millions; scab and worm to the apple crop of over half a million—not to speak of dozens of other pests of other crops, causing a very large aggregate loss. Inasmuch as it was impossible for the Society with the limited means at its disposal to undertake propaganda work among the Quebec farmers themselves, it adopted from the outset a plan to furnish reliable information to those who came into direct contact with the farmers. It therefore prepares an Annual Report which is published in both languages by the Department of Agriculture, containing both popular and technical articles relating to the pests that cause loss. The popular articles were intended for the

average reader and the technical articles for students and others who were seeking for information regarding the nature and structure of the causal organisms. The nine Reports that have been published have, I believe, fulfilled the expectations of the founders of the Society. They have been well received, and have been given commendation by scientific workers in other provinces and in the United States and Europe.

Third, the Society had as one of its main objects the promotion of the sciences of Entomology and Plant Pathology in this province. It has published as supplements to the Annual Reports three *Lists of the Insects of Quebec*, the *Lepidoptera*, compiled by Mr. A. F. Winn; the *Diptera* by Messrs. Beaulieu and Winn and the *Coleoptera* by G. A. Chagnon, which should serve as useful guides to systematic collectors. I hope that similar lists of Fungi of Quebec will be prepared in the near future. For various reasons the study of fungi has been undertaken by but few persons in this province, so that a large and inviting field is open for workers along this line. I believe, however, that the impetus given by this Society is stimulating more scientific research on botanical subjects, and is calling out more of our young men to study along these lines. There is even a greater demand for trained men in Plant Pathology than in Entomology on account of the scarcity of competent workers.

Remarkable progress has been made in economic entomology and plant pathology during the past decade, not only in Canada but also in all parts of the world. Our own province has made great strides, more especially in entomology. In 1913 Canon V. A. Huard, well known as the editor of *Le Naturaliste Canadien*, was made Provincial Entomologist, and held this position until 1916 when he resigned and Mr. George Maheux was appointed to the office. In the same year Mr. Letourneau was made professor of entomology at the Oka Agricultural Institute, so that students are now graduated prepared to deal with entomological problems. Macdonald College has given considerable attention to entomology and plant pathology ever since it opened its doors to students in November 1907, and several of its graduates now fill positions of responsibility in Dominion and Provincial service.

Quebec is fortunate in having two valuable reference collections of insects and entomological works—one containing the collections of Provancher and Dr.Fyles, in Quebec, presided over by Canon Huard, and the other, the bequest of the late H. H. Lyman, at McGill University, presided over by Mr. A. F. Winn. On account of its large fruit interests, Ontario has for many years given attention to economic entomology and plant pathology. In 1912 a provincial entomologist was appointed, his duties covering both fields, but he has a corps of assistants. Nova Scotia also has her official entomologist, and through his influence a great impetus has been given to the study of insects in that province.

But the greatest and most far-reaching development has taken place in connection with the Dominion Service. On the death of Dr. Fletcher in 1908 the Division of Entomology and Botany was made into two, each with its own staff of officers and workers. It is unnecessary for me to tell this Society how these Divisions have grown during the ten years of their separate existence, how field stations have been established in every province, and how problems are being studied by specialists in the open field. For details regarding the activities of these two branches I would refer you to Dr. Hewitt's Presidential Address, Ontario Entomological Society 1915, and to Mr. Gussow's article in last year's report of this Society.

The development of these two economic branches of science in the United States Department of Agriculture during the last decade has also been truly marvellous. The corps of scientific workers numbers nearly a thouasnd, and the problems that are being investigated are manifold.

A characteristic feature of recent progress has been the publication of a large number of excellent text and reference books. Ten years ago economic works dealt rather generally, or vaguely and indefinitely, with the forms discussed, and details were to a large extent wanting. Recent works are more specific in their treatment, as for example the Manuals prepared by Slingerland and Crosby on *Fruit Insects*, by Herrick on *Household Insects*, by Sanderson on *Farm, Orchard and Garden Pests*, by Riley and Johannsen on *Medical Entomology*, by Herms on *Parasitic Entomology*. These works represent the results of many observers in all parts of North America who are studying the pests intensively, their results having first appeared usually in bulletins or in periodicals.

In Systematic Entomology also several works have appeared that are of great value to the economic investigator, namely Blatchley's *Coleoptera of Indiana*, Blatchley and Leng's *Rhynchophora of North America*, Aldrich's *Sarcophaga and Allies*, Brues and Melander's *Key to the Families of North American Insects*, Barnes and McDonnough's *Check List of the Lepidoptera of Boreal America*, and VanDuzee's *Catalogue of the Hemiptera of America North of Mexico*. Lutz's *Field Book of Insects*, Needham and Lloyd's *Life of Inland Waters*, and Ward and Whipple's *Fresh Water Biology* just recently published are valuable aids to the student who desires to pry into the secrets of Nature in the open. Folsom's *Entomology with reference to its Biological and Economic Aspects* is most valuable as an introduction to the anatomy, physiology and ecology of insects. It leads on to Packard, Henneguy, Newport and Lyonnet.

The *Journal of Economic Entomology* and the *Annals of the Entomological Society of America* began publication in 1908, the year of the organization of our own Society.

In Plant Pathology Duggar's *Fungous Diseases of Plants*, Stevens and Hall's *Diseases of Economic Plants*, Stevens' *Fungi which cause Plant Diseases*, Hesler and Whetzel's *Manual of Fruit Diseases*, E. F. Smith's *Bacteria in Relation to Plant Diseases* give detailed information regarding the diseases discussed, thus placing at the disposal of students much of the information which was heretofore available only in widely scattered bulletins and periodicals. Mention should be made also of the recent works of Massee, Kuster, Sorauer and Harshberger, which discuss at greater length certain aspects of fungi that are merely touched upon by the writers mentioned above.

The American journal *Phytopathology* belongs to this decade, its first number having appeared in January-February, 1911.

Perhaps the most outstanding feature of recent work against insect and fungous pests has been the introduction of new and improved methods of investigation and control. Each pest is being studied, as far as possible, under natural conditions in the open field, with the object of determining all the factors that play a part in the life of both host and pest. No phase is too trivial for examination, for it sometimes happens that apparently trivial and minor factors turn out to be important; for example, the discovery of a pre-oviposition period for many Diptera furnishes us with a means of controlling them at this vulnerable period. The study of parasites has given us an increased knowledge of the habits of these friends, and greater use is being made of them in combatting some of our worst pests.

In a word, the ecological relations of insects and fungi have been studied to much advantage. But these relations are often very intricate, and only a beginning has been made in their investigation. Isolated facts have been determined, but general principles have not yet been discovered. It is becoming clearer every year that we are woefully ignorant of many of the most important ecological facts concerning the most common economic insects. It is becoming clear also that the entomologist must co-operate with the physicist, the chemist, the physiologist, and the geologist before important advances can be made towards the solution of most of the problems confronting the ecologist who has to deal with the dynamic relations of the organism and its environment.

Great advances have also been made in the use of insecticides and fungicides. New chemicals have come into use, and old ones have been modified. Spraying machinery has been greatly improved so that more effective results are secured.

Time prevents me from describing further many other advances that have taken place during the last decade, but enough has been said to show the wonderful strides in our own sphere of activity.

Our younger men are fortunate in the possession of so many advantages ver the older men who had to labor under great handicaps. With their greater opportunities may we not hope for increasingly greater progress in the next ten years. Our Society enters the second decade of its existence under happy auspices, and I look forward hopefully for an increased membership of young men trained in the new school, able to carry on the good work done by the men who founded the Society.

A FEW NOTES ON THE LIFE OF ABBE PROVANCHER.

Canon V. A. Huard, D.Sc., Quebec.

The Dominion Entomologist, Dr. C. Gordon Hewitt, in a letter which he wrote to me recently, stated that he believed Abbé Provancher and his work are better known and more admired outside the Province of Quebec than within it, and I think he has good reason for making this assertion. Of course we must remember that Provancher has been dead twenty-five years, and few memories can stand such a test of time. I think most of us must resign ourselves to the fact that we too shall be well-nigh forgotten a quarter of a century after our death. Moreover, Abbé Provancher passed the last twenty years of his life in a sort of retreat in the country, which of course did not tend to add to the number of people who knew him personally. He came before the public, it is true, between the years 1869 and 1892, but this was by reason of the technical books which he published, and these books came to the attention of comparatively few inasmuch as they related principally to entomology. As few sciences have been so lightly valued by the general public in the Province of Quebec, it is not surprising that Provancher's name remains unknown to the larger part of our people. Outside of Quebec, on the other hand, wherever Canadian and American entomology is studied Provancher's work on the Insects of Canada is valued. The number of societies and individuals interested in the study of entomology in other countries is very considerable, and this would account for the fact, somewhat surprising at first sight, that Provancher is today better known to strangers than to his own countrymen. Moreover (and I say this with the greatest modesty) if the name of my illustrious master and friend has been kept alive in the Province of Quebec it is largely due to the *Naturaliste Canadien*, which frequently recalls the memory of its founder.

Last year I had the pleasure of presenting to the members of the Quebec Society for the Protection of Plants a study on the entomological work of Provancher. It has been suggested to me this year that in order to make it more complete I should add a few notes on the chief events of his life. It gives me great pleasure to do this, and to enlarge on what I have already written about Provancher and his work.

Leon Provancher was born at Becancourt, Nicolet, on March 10th, 1820. After passing the earlier years of his life in this old country parish he commenced his classical studies at Nicolet College in 1834, where he showed his taste for

natural history, thanks to a certain book dealing incidentally with botany which fell into his hands. But when he tried to recognize in living flowers the various parts referred to in the book, he found himself stranded, and could not find anyone amongst the college staff to help him out of his difficulties. There were amongst them men of talent, and the college had a high standing in those days just as it has now, but at that time, nearly three-quarters of a century ago, very little attention was given to natural science.

Young Provancher finished his course of study in 1840, and took up theology at the same college. After finishing this course he was made professor of oratory, succeeding Abbé Lafléche, who was in the future to be appointed to the episcopal see of Three Rivers. Nicolet at that time being still part of the diocese of Quebec, young Provancher, in company with four others, was ordained a priest in the Cathedral of Quebec on September 12th, 1844. Of the five candidates two were later made bishops, Mgr. J. Langevin, bishop of Rimouski, and Mgr. A. Racine, bishop of Sherbrooke.

From 1844 to 1847 Provancher was priest of Becancourt, his native parish, St. Francis de Beauce and Ste. Marie de Beauce. In 1847 he was one of the forty-two priests (among whom was the future Cardinal Taschereau) who went to Grosse-Ile to look after Irish immigrants who were suffering from an epidemic of typhus. Nearly half of the missionaries contracted the disease and four of them died.

After acting for a year as assistant parish priest at St. Gervais, Provancher was given charge of the new curacy of St. Victor de Tring, where he took up the study of horticulture, particularly grafting, indeed with no success. Four years later he was transferred to the cure of Ile-Vert, and two years later, in 1854, to that of St. Joachim (Montmorency), where he spent eight years, 1854 to 1862. He extended the church there, and introduced during his first winter the use of stoves. For we know that our fathers up to that time had not imagined it possible to heat their churches at all.

It was at St. Joachim that Provancher began his career as a naturalist and writer by the publication of his "Traité Eléméntaire de Botanique" in 1858 and "Un Tableau Chronologique at Synoptique de l'Histoire du Canada" in 1859. From 1862 to 1869 he was parish priest of Portneuf, and while there he managed to reduce the parish debt; introduced music into the church in the form of a harmonium, which he went to Boston himself to purchase; established a system of churchwardens; founded in 1866 the first brotherhood of Franciscan Third-Order in the country, and took steps to bring back the monks of St. Francis d'Assise, which was not, however, accomplished until some time later. In addition he organized a navigation company with boats between Quebec, Portneuf and other points.

It was at Portneuf, at the end of 1862, that he published his great work "Une Flore Canadienne," the first work of this nature published in Canada. The same year saw the publication of the "Verger Canadien," also the first of its kind which had appeared in Canada, and which reached in 1885 its fifth edition. This was not the only way in which he busied himself there, for he worked hard to form in his parish a company of militia, and he also established an extensive nursery. In 1868 he commenced the publication of a journal which he called the *Naturaliste Canadien*, which he edited for twenty years, a period which it has been given to me to increase by an additional twenty-four years. In 1869 he left his ministry and settled first in Quebec, then at Cap Rouge, when he passed the last twenty years of his life.

The last twenty years of Provancher's life were filled with a variety of activities. I have only time to mention a few of them—his regular contributions to *La Minerve*, an important Montreal journal, up to 1870; his travels in Petit Antilles, Europe and the Orient; his two Canadian pilgrimages to Jerusalem, when he organized and personally directed one of them; his religious writings; his volume on "Les Mollusques de la Province de Quebec;" his "Cours Eléméntaire d'Histoire du Canada pour les Ecoles," and the foundation in 1888 of "La Semaine Religieuse de Quebec," which he turned over to other people at the end of four months, and which will soon complete its thirtieth year.

But it was in the midst of all this, and during the last twenty years, that Abbé Provancher undertook his great work on entomology. A description of all the different species of insects in a country was a task which no one had hitherto dared to undertake, but he undertook it for the province of Quebec. This was "La Petite Faune Entomologique du Canada" in which he describes all the species of Coleoptera, Hemiptera, Orthoptera, Neuroptera and Hymenoptera of Quebec, including three or four hundred species hitherto unknown. This work comprises four volumes, and about two thousand pages in all. Two other volumes on Diptera and Butterflies were to have completed this great work, but he was unable to procure funds for their publication. However, as he has elsewhere dealt in detail with plants, animals, birds, fishes and reptiles it may be said that he has left us a natural history of the province which is almost complete.

The above brief sketch will suffice to show to what a point Abbé Provancher carried his pioneer work in Canada, and I think few men have ever shown greater initiative. He died after a short illness on March 23rd, 1892, in his seventy-second year, and was buried in the parish church of Cap Rouge.

It may be of interest to add that the two papers which he founded, *La Semaine Religieuse de Quebec* and *Le Naturaliste Canadien*, are still in existence twenty-five years after his death. His scientific library is today part of the

Quebec Legislative Library. Of the three insect collections which he got together one is at Levis College and the other two are in the Museum of Public Instruction at Quebec.

In conclusion I may say that in the autumn of 1917, there being nothing in the church of Cap Rouge to indicate that Abbé Provancher was buried there, I opened a subscription list in *Le Naturaliste Canadien*, which was remarkably successful, and which enabled me in February last to have a marble monument placed on the grave of our illustrious savant, who has well merited the title of "the Linnæus of Canada."

NOTES ON THE WHITE-MARKED TUSSOCK MOTH.

By Dr. J. C. Chapais, St. Denis-en-Bas, Quebec.

In Eastern Quebec, our orchards were invaded, in the course of last summer, by an insect already known, but which, in 1917, spread itself as a true plague in our region.

That pest is known under the common name of the White-marked Tussock Caterpillar, which is the larva of the *Hemerocampa leucostigma*, in French: *L'Orgye à taches blanches* ou *l'Hémérocampe marquée de blanc*, its common French name being: "*Le papillon crépusculaire à touffes, marque de blanc.*"

The larva of this insect is one of the prettiest that we have. "When matured it is more than an inch long, of a bright-yellow color, with the head and two small protuberances on the hind part of the back of a brilliant coral-red. Along the back, there are four cream-colored brush-like tufts, two long black plumes on the anterior part of the body, and one on the posterior. The sides are clothed with long, fine yellow hairs. There is a narrow black or brown stripe along the back, and a wider dusky stripe on each side." (Saunders).

Though many entomologists have written that there are two broods of this species in one season, we have ascertained that in Ontario and Quebec there is only one. This has been verified by Mr. Caesar, entomologist at the Guelph Agricultural College, Ontario, who thus corroborates our own assertion.

The female insect has no wings or simply rudiments of wings. When it emerges from its cocoon, by the end of August, it lays from 300 to 500 eggs. It deposits these upon the cocoon and covers them with a whitish, sticky substance which hardens when exposed to the air. The eggs hatch in the following spring, by the end of May, when tiny caterpillars emerge from them and begin immediately to feed upon the leaves of the trees which constitute their nourishment, till they have attained their complete development, after a period of about one month. Then they begin to spin their cocoon on the leaves of the tree where they grow. After about a fortnight the winged male insects and the wingless female insects emerge from their cocoons.

After it has escaped from its cocoon, by the end of August, the female patiently waits the attendance of the male and then begins to lay its eggs as mentioned above.

To prevent damage and the multiplication of these insects, one must, 1st, have recourse to the hand gathering of the cocoons laden with eggs that are found on dead leaves attached to the bark of trees and, here and there, in cracks of fences,

in bark crevices, in the grooves of the outsides of wooden houses, etc. It is recommended to keep those cocoons through the winter in boxes covered with wire netting, till spring, as they may have for tenants not only the chrysalis of the Tussock Caterpillar but also the pupae of Diptera or Hymenoptera, parasites of these caterpillars, and these would be killed if the cocoons were burnt in the fall. If they are kept till spring, they will have a chance to survive and to help us to destroy the coming caterpillars.

One must also, 2nd, have recourse, in May and June, for the destruction of the caterpillars, to the sprays used for the control of the tent caterpillar and other kinds of insects.

THE WHITE PINE BLISTER RUST SITUATION IN QUEBEC.

By Henri Roy, F.E., Forest Service, Quebec.

I have accepted with pleasure the invitation extended to me by the secretary of your Society to lay before you the results of our investigations last summer on the "White Pine Blister Rust Situation in Quebec."

As there has been a good deal of publicity about this disease, with which the members of this society are fully acquainted, I shall confine myself to the description of what has been done in this province, and of what remains to be done. I shall also endeavour to ascertain from the data secured up to date what may be the consequences of this disease in regard to our reforestation policy.

What Has Been Done.

As a result of the discoveries made in the United States, especially in the States of New York, Vermont, New Hampshire and Maine, in the neighbourhood of our frontiers, as well as those made in Ontario and even in some scattered points of our own territory, a general reconnaissance was necessary. With the co-operation of the Dominion Department of Agriculture, who defrayed the travelling expenses of our inspectors, the Forest Service of Quebec undertook the examination, under the supervision of Mr. G. C. Piché. As a first step two forest engineers, Mr. Gosselin and the writer, went to the Laboratory of Pathology at St. Catharines Ont., to obtain from Mr. W. A. McCubbin additional information on the progress of the work in Ontario in order to benefit by the experience gained, so as to make good field inspection and to collect data of value. It was impossible to send out our inspectors in due time for a thorough inspection of the white pine; as a matter of fact, it was not before the fifteenth of June that most of our men could reach their respective districts. For this reason we have confined ourselves almost exclusively to the search for the disease upon the leaves of goosberries and currants; yet we have collected enough data to map a good number of the old stands and reproduction areas of white pine in the patrolled territory, and numerous trees growing in the vicinity of gardens were duly examined.

These investigations never disclosed the presence of the disease on the trees. Moreover, we were unable to make any positive diagnosis even on those seedlings shipped from the Guelph Nursery, which were suspected of scattering the disease in this province after being planted here. Another inspection would be necessary at the "blister" stage at Pointe du Platon, Lotbiniere county, and here in St. Annes, where some of these seedlings were brought, because the rust on the

Ribes appears here early enough in the season to induce us to believe that there are at least these two centres of propagation.

The Inspected Territory.

On the South shore of the St. Lawrence the patrolled area includes all the territory east of Lotbiniere, Megantic and Compton counties—in all eighteen counties. Only a part of the counties of Portneuf, Champlain, St. Maurice and Three Rivers was inspected on the North Shore. In the Ottawa district, in the home of white pine, we visited the lower valleys of the Lievre, Noire, Coulonge, Gatineau and Rouge rivers, located in the counties of Pontiac and Labelle, and also the valley of the Ottawa itself, as far North as Des Quinze river. Around Montreal the counties of Soulanges, Vaudreuil, Laval, Deux Montagnes, Argenteuil, Hochelaga and Jacques-Cartier were also inspected more or less thoroughly.

The Area Infested.

We found the disease in the counties of Lotbiniere, Nicolet, Wolfe, Megantic Richmond, Sherbrooke and Shefford; at least 275 cases of distinct infection were traced, so that it seems this area is deeply affected. As one would suppose, the disease was located along the main roads, and in certain localities it seems to spread particularly along the right-of-way of the railroads.

As all this section is situated in the Appalachian district, the topography is somewhat rugged where the forest areas are still pretty well represented. It is also worth mentioning that in all this section there are but few plantations of currants or gooseberries, cultivated from a strictly commercial point of view; in fact, for domestic use, these plants are not found on more than 30% of the farms. The white pine, which was once thoroughly distributed here as a commercial species, has disappeared, as such, and is to be met only in small groups or as isolated trees in few localities, and also as ornamental trees in the villages and towns. Our inspectors have noticed the presence, under forest cover, of wild gooseberries and currants in abundance.

It is also plausible that the infection may be propagated at the same time from the Lotbiniere property at Pointe du Platon and from the United States boundary line, so that in a short time the disease may spread over the whole intermediate area. But this is a mere supposition, and a more detailed examination may lead to the discovery of few other centres of propagation.

Across the St. Lawrence the rust was found to be widely spread in the parishes of St. Anne de la Perade, Batiscan and Champlain, in particular along the

Montreal-Quebec highway. This section is nearly devoid of either native or planted white pine. As gooseberries and currants are met infrequently on the farms it would seem that the rust has been brought to these places from infected plants on the South Shore where the banks project toward the county of Champlain. What leads to this conclusion is the fact that it was not before a second inspection, which took place in October, that we discovered the rusted plants.

In the Ottawa valley, where the examination was very rapid, owing to the extent of the area to be covered and to the sparsity of the agricultural communities, what has been done leads us to the conclusion that this area is yet free from the disease.

However, we are informed by Mr. W. A. McCubbin that one case of infection has been traced in the neighborhood of Pembroke, Ont., which is very close to Quebec, in the very heart of the white pine habitat in the Ottawa region. In Jacques-Cartier county, where the rust had been reported last year, it reappeared again this year.

What Remains to be Done.

As a result of this reconnaissance it may be said that the "White Pine Blister Rust" is spread more widely in our province than we had thought and to such an extent in certain districts that there seems to be almost no means to control it.

It will be necessary to go over all the territory inspected last year, owing to the incomplete inspection made, to detect, if possible, if there are pines affected.

We do not know how far east of the counties of Lotbiniere and Megantic the disease has spread. On the North Shore, when the rust was discovered in Champlain, it was too late to go around the infected area, and around Montreal we had to abandon the inspection for the same reason. In the counties bordering the international frontiers, our inspectors could not find any rust, but that may be due to the fact that we sent them too early in the season in that section. It is well to notice that almost all the discoveries were made during September and October, those in Lotbiniere, Nicolet and Jacques-Cartier excepted, and that in the counties of Champlain, Sherbrooke and Shefford it was a second inspection which took place in October that led to the discoveries. We were taught by experience that the period extending from the fifteenth of August to the fifteenth of October is the most suitable for the inspection of this disease on *Ribes* leaves, as far as our conditions are to be met. Along with this reconnaissance work, we should establish a few sample plots where we could make a careful count of the number of wild currants and gooseberries to the acre and also establish the approximate cost of eradication.

This information is needed so that we may have data at the end of next season to outline a definite policy. This question is now in the hands of the Federal authorities.

The Economic Importance of the Disease.

From what we have seen, it is evident that we are not yet in a position to foretell with exactitude what will be the damage to our forests of white pine. Until a few years ago, we thought the rust absent from our province, expecting it would never reach us, but the inspection of last year has proved the contrary, and it may happen that next season's work will compel us to lose our last hopes.

We must consider now the problems of growing white pine on our nurseries; that is to say, should it be our policy, until evidence to the contrary is brought forth, to believe that it is impossible to stop the progress of the disease, and, with this in view, to find out by successive and repeated experiments to what extent our white pine seedlings, etc., are liable to be endangered by it. The only way to get reliable data regarding the immunity of white pine in relation to the age, size, mixture in stands, nearness of *Ribes* will be by sample plots of diversified conditions of climatic and other ecological factors. This would require a long time for adequate solution, and we must keep in mind that in sylviculture the conclusions from experiments are obtained far more slowly than in agriculture, for similar diseases affecting young or smooth tender bark studies pursued about ten years will give satisfactory data to frame our reforestation policy.

It would be very regrettable if we were to discontinue definitely the growing of this species in our nurseries, without having previously established by strong arguments the necessity for such a step. The reforestation idea is just getting a start here; the lumber supply is becoming scarcer in many localities, and the reforestation of infertile lands, of barren tracts denuded by lumbering or fires is already an enterprise, which, especially in densely populated districts, commends itself from the financial point of view. One of the essential conditions for its success, however, is that the invested capital be justified by the future yield of the species used, and, up to the present, the white pine seems to be the one which yields the best expectations on account of the rapidity of its growth as well as by the value of its lumber. We must add that the white pine is a species well fitted for planting most of the waste lands of the Laurentians and Alleghany mountains, as also for the St. Lawrence plain.

We cannot advantageously substitute either the Red Pine, whose lumber has a lower value, or any of our other indigenous conifers on account of their slower growth. The exotic species, amongst which there are a few which seem to thrive well under our climate, are still at the test period, and we cannot rely upon them.

There is also the tamarack, but owing to the dangers to which it is exposed, the use of this species on a large scale would bring results worse than the evil itself. I did not mention as general substitutes the deciduous trees because in this respect our forests were practically untouched, so that in our reforestation projects we must use only species of the highest value as accessory species in order to minimize the dangers to which pure stands of resinous species are particularly subject through insect attacks or fungous diseases.

Morever I may remind you that our white pine reproduces itself so poorly in the forest that if man does not help nature, this species within a few more decades will have ceased to be of commercial importance. For these reasons we should not abandon white pine culture immediately, even if the disease proves to be more widely scattered, for it may be less injurious that it was in the European nurseries, where white pine had to be abandoned. I venture to say that we could submit the nurseries to many experiments to make the evidence more complete and conclusive.

Moreover, our forests are endangered by numerous other potential enemies waiting for favorable circumstances to break out. You are aware that a few years ago the spruce bud worm (*Tortrix fumiferana*) threatened to destroy our spruce with far greater rapidity than the rust would ever kill our seedling stock, but fortunately it was checked in due time by natural parasites.

Undoubtedly you were told that the balsam fir, in most of the forest districts of this province, is injured by the attacks of a somewhat similar larva and to such an extent that, according to a forest investigation made last summer in the Upper St. Maurice, we found out of a total of 102 balsam trees per acre an average of 41 dead and 30 in a dying state. We must admit, therefore, that this is a very serious situation.

Everybody has still in mind the time of the notorious *Nematus Erichsonii*, which has killed our tamarack. We are not quite free from this pest which thrives in our woods and nurseries awaiting perhaps the favourable conditions which prevailed years ago to reappear.

Our white pine reproduction is badly hindered by the white pine weevil, which was found by our inspectors in the whole area covered last summer. It would be interesting to determine which of the two, this pest or the rust, will prove the worse in the long run in the reproduction of this species. If we pass to the fungous diseases we find that there are thousands of trees affected by them; the debris which we are wont to take as necessary waste in lumbering operations tells us how much there is to be learned yet in forest biology.

I cannot conclude these remarks in a pessimistic tone; I would be sorry to leave you under the impression that we do not fully realize the serious nature of

the problem with which we are now dealing, but I want to make it plainly understood that the white pine blister rust, if pretty well known, may not be after all the worst of our forest pests, and I hope that nature will help us in the control of it.

My last word will be to note with satisfaction the fact that for the first time as far as I know, our governments, Federal and Provincial, have taken an interest in the control of a forest tree disease and on such a scale that it justifies the best hopes of the friends of the plants.

WARBLES AND BOTS.

By A. E. Cameron, M.A., D.Sc., F.E.S., Technical Assistant, Entomological Branch, Department of Agriculture, Ottawa.

(This address was illustrated by many original lantern slides.—Ed.)

Warbles are confined to the bovine race and bots to horses. Exceptionally, they are found in man causing "cutaneous myiasis."

WARBLES

There are two species, *Hypoderma bovis* DeG., and *Hypoderma lineatum* Villers, both affecting cattle and generally distributed throughout the world wherever domestic breeds are kept. From the similarity of their habits and general appearance, there seems to have been much confusion in their discrimination in the older literature, but much of the difficulty has been eliminated by the researches of Curtis[1] and Schaupp[2] in the United States, Carpenter and Hewitt[3] in Ireland and Hadwen [4-8] in Canada, not forgetting the splendid work of Bracy Clark[10] in 1815 in his "Essay of the Bots of Horses and Other Animals. Osborn[13] has also made a valuable contribution to the study.

Briefly, the characters distinguishing the two species may be stated as follows: *H. lineatum* is a less robust and more slender fly than *bovis*, and, whereas the dense yellow hair on the anterior dorsal region of the thorax partially obscures the presence of four lines in *bovis*, in *lineatum* these lines are quite distinct. In *bovis* the investing body hairs are predominantly yellow with the exception of those on the scutellum and base of the abdomen, which are yellowish white. On the apex of the abdomen they are a bright lemon yellow. In *lineatum* the body hairs are yellowish white except those on the posterior extremity of the body which are orange red. In both species the ground colour is black, appearing prominently as a band on the posterior region of the thorax and middle region of the abdomen. In the wings, the veins of *bovis* are not so dark as those of *lineatum*, and the tarsi of the former are more sparsely endowed with bristles than are those of the latter. Of the two, the resemblance of *bovis* to a honey-bee is much more pronounced than *lineatum*.

Entrance of Host by Larvae.

Previous to the discoveries of Curtice[1], who presumed to have proved that the normal course of entrance (*lineatum*) within the body of the host is by way of

the mouth and alimentary canal, it was generally supposed by some writers that warble larvae penetrated through the skin. Bracy Clark (pp. 408-409) was strongly of this opinion, although he was wrong in his belief that the eggs were simply laid on the skin. At a later date Ormerod[14] stated of *bovis* that the larvae made direct entrance through the skin. Reaumur, quoted by Osborn[13] (p. 92) one of the earliest writers, went a step further by asserting that the adult punctured the host's skin with its ovipositor and introduced the egg beneath. He was, no doubt, partly drawn to this inference by interpreting the great terror of the animals as being symptomatic of pain experienced when the operation of oviposition by the fly was being effected.

Course of Larva Within the Host.

In an experiment undertaken by Hadwen and Bruce[7] on November 17, 1914, four warble larvae were dissected from the gullet of a cow and introduced beneath the skin of a calf three weeks old in the region of the knee. The larvae were about 1 to 1.5 cm. long. On December 7th two of the larvae made their appearance on the calf's back, puncturing the skin just behind the scapula. In tracing the course which the larvae had taken, the authors found that the track was distinctly visible, passing from the knee to the radius and hence up to the elbow-joint, whence it could be followed under the scapula. Evidently these larvae had not re-entered the gullet.

In making their way from the gullet to the back of the host, the larvae first of all gradually work their way to the posterior end of the gullet where the muscle fibres are widely separated. Making their way beneath the reflexed pleura of the oesophagus and diaphragm it is supposed that, passing downwards and outwards, the larvae gain the cartilages of the ribs. Thence they proceed along the posterior border of the ribs between the intercostal muscles until they reach the upper intercostal space. By passing between the external intercostal muscle and the *levator costarum* and thence between the *longissimus dorsi* and the *transversalis costarum*, they finally reach the skin of the back. The larvae invariably adhere to the connective tissue between the muscles.

Hadwen and Bruce (*loc. cit*) also found evidences that larvae may enter the spinal canal by either the posterior or intervertebral foramen, and actually encountered several larvae in the spinal canals of different animals. They quote Carpenter (p.11) as having found larvae outside the muscular coat of the gullet in the thoracic region close to the diaphragm.

Seasonal Appearance.

The two species do not appear on the wing synchronously, and it is interesting to note in this respect that *lineatum* first makes its presence known as an adult

about the middle of April and continues to annoy cattle until the middle of May. On the other hand, *bovis* is to be observed for the first time at the begininng of June, and specimens have been captured by Hadwen as late as July 25th, whilst cattle have been noted a few days afterwards behaving as if tormented with this species.

It will be thus seen that as regards their adult activities and seasonal appearance, the two species are mutually exclusive, and it is very improbable that they will be both present among a herd of cattle at the same time.

The comparatively early appearance of *lineatum* has an important bearing in relation to the undertaking of prophylactic measures, and this combined with the more inoffensive behaviour of this species has probably been responsible for the fact that the application of special dressings on cattle has been made too late to be of any avail in reducing the intensity of egg-infestation.

Oviposition.

The attacks which the flies make on the cattle are for the purpose of depositing their eggs on the hair. The method employed by *lineatum* is much more unobstrusive and gentle than that of *bovis*. In a rapid, blundering fashion, *bovis* selects the animal which it intends to 'strike,' and with its telescopic ovipositor extended makes a headlong, speedy flight at its host. The double valved ovipositor slides down the particular hair chosen and the egg is rapidly extruded and left behind at the base of the hair in close proximity to the skin. There it is firmly fixed by the clasping flanges of the pedicel, the attachment being more firmly secured by the presence of a gluey substance secreted at the time of egg-laying.

In contrast to these methods are those of *lineatum*, which generally prosecutes its business of ovipositing when the cattle are in a recumbent position. It may then be observed according to Hadwen[6] (p. 4) to run backwards along the ground in approaching its host, and pushing its ovipositor among the hairs, leaves its egg behind. Several eggs may be laid on a single hair, whereas *bovis* usually lays but one per hair. The animals show some annoyance and irritation when *lineatum* attacks them as they are standing, but they do not generally stampede in such abject terror as *bovis* with its more clumsy methods inspires.

Remedial Measures.

Warble-flies may be attacked in three different ways as follows:

(1) Prevention of egg-laying.

(2) Destruction of eggs and newly emerged grubs.

(3) Extraction of grubs from the back.

The methods recommended here have been tested time and again all over the country. Osborn[13] (p. 94) advises coating the backs of animals from neck to loins with tar, or with a mixture composed of sulphur, 4 ounces; spirits of tar, 1 gill; whale oil, 1 quart; this preparation to be applied once a week. This measure is unfortunately not practicable among the large herds on big ranches.

The application of kerosene to the eggs before they hatch will kill the grubs inside. This is also a rather tedious process.

From January onward the grubs appear on the back, and measures should be promptly adopted to squeeze them from the tumors. After the bots have been removed, the tumors should be dressed a few times with vaseline in which carbolic acid has been mixed, or with some other healing antiseptic ointment. In order that the full benefit of such a measure as this might be derived, it would be necessary that co-operative efforts should be adopted throughout the country. Nevertheless, individual stock owners who adopt this measure would find that they would secure practical immunity in their own herds, since the fly travels only short distances.

It is sometimes advocated that the grubs be killed inside the tumors by the application of kerosene or mercurial ointment, but it will be readily understood how the absorption of the resulting putrefying products of the dead grub would be deleterious to the systemic functions of the host. The non-absorption of the chitinous cuticle, however, may be the cause of a persistent abscess.

In districts where arsenicals or crude petroleum dips are regularly applied to cattle to combat infestations of ticks, it has been found that the animals are, to some extent, also protected against the attacks of warble-flies as well as blood-sucking flies.

Anaphylaxis and Warbles.

The term anaphylaxis is used in medical and veterinary science to designate these reactions which follow the injection of foreign albuminous substances, not in themselves toxic, into an animal which has previously been rendered sensitive by a previous injection of the same substances. The symptoms, under certain conditions, may be markedly toxic or even fatal.

The conditions necessary to the production of anaphylactic shock may already exist naturally in an animal infested by parasites or which *has been* infested by parasites and the characteristic symptoms, as shown by Hadwen and Bruce[8], may readily develop in such cases where the extracted body-juices of the specific parasite are re-injected into the particular host. This not only applies to warbles

but to bots and parasitic worms. As regards the practical significance of the reaction, it may be found to furnish a useful index of the presence or absence of parasites in a mammalion host. For instance, the instilling of a tiny drop of warble extract diluted in water will cause a copious flow of tears and conjunctivitis, if the animal is or has been affected by warbles. The injection of bot extract in a cow will not produce any effect, since cows are not parasited by bots and therefore have not been rendered sensitive to the particular proteins of bots. Extracts of adult warbles and bots will produce the same reactions as the larvae.

In conclusion, it should be remarked, as the experiments of Hadwen and Bruce (*loc. cit*) show, that the test is not always infallible, and some animals may develop a condition of immunity which will produce negative results even on repeated injection of the specific protein. This immunity is not very well understood.

From a practical point of view the enlargement of our knowledge on this particular set of reactions has been the means of offering a satisfactory explanation of the serious effects which often follow the abrading and bursting of the warbles on the backs of cattle, whether this arises from rough handling of animals or accidental circumstances. The animals may die of anaphylactic shock. Similarly, the small oedematous swellings—called by Hadwen[6] (p. 7) "hypodermal rash"—produced at the point of entrance of warble larvae into their hosts, are an indication of the animals' response to the reaction.

BOTS.

Introduction.

Three species of bots are known in America; but whereas *Gastrophilus intestinalis* DeG., the common horse-fly, is widely distributed throughout the country and is best known because of its abundance and comparatively slow flight, the chin fly, *G. nasalis* L., and the nose fly, *G., haemorrhoidalis* L., do not seem to enjoy the same wide distribution. It is just possible, however, that *nasalis* will be found throughout Canada, both east and west. Bishopp[16] (p. 183) has traced its presence in most of the states of the union. *G. haemorrhoidalis*, which is perhaps the most annoying of the three species in its habits of ovipositing, is less known than the other two species and has often been confused by the layman with *nasalis*. Bishopp (*loc. cit.*) has established its presence in eight states of the west and middle west, its eastern distribution extending to the state of Wisconsin. In Canada, the author and Hadwen have records of its presence in Alberta, Saskatchewan and Manitoba.

The mode of dissemination of bots is almost entirely determined by the movement of horses. Therefore, the author can see no reason—unless they be climatic—why the nose-fly should not spread from infested to non-infested regions with parasitised animals. In recent years there has been extensive shipping of animals from western provinces to eastern army depots, where the animals are congregated previous to their being re-shipped to Europe and to the picket line. It is quite feasible to suppose, therefore, that this species might become established in the east, if it has not already done so.

All three species of bot-flies exist in Europe, whence they no doubt originally came to the American continent. Just why the nose-fly did not distribute itself so widely as the other two species is not clear. It may have been that it found eastern environmental conditions unsuitable. But as to whether its absence here is correlated with conditions that are more humid in the east than in the west, as Bishopp suggests (p. 186) is a moot point. At least, the humid atmosphere of England has not entirely checked its activities there.

Last summer (1917), Dr. Hadwen and the author made an investigation of the three species of bot flies in Saskatchewan, when some interesting results were obtained. These have been incorporated in a paper entitled "A Contribution to a Knowledge of Bot-flies, *G. intestinalis* DeG., *G. haemorrhoidalis* L., and *G. nasalis* L.", which the authors expect to be published soon.

Oviposition.

The eggs of *G. haemorrhoidalis* are black and are shaped somewhat like a barnacle. The stalk is grooved and serves to attach the egg to the hair. Contrary to the opinion of Parker[18], the stalk of the egg does not penetrate the skin of the host. The eggs are invariably laid on the hairs of the lip, usually on those of the lower and less frequently on the upper.

The yellowish eggs of *G. nasalis* are laid on the rather long hairs of the intermaxillary region and are not exposed to view. They are elongate ovate and bear two attaching flanges which run almost the whole length of the egg. When there are several eggs on the same hair, they are generally arranged in close series.

The eggs of *G. intestinalis* are yellowish white, the clasping flanges running about three-fourths of their length. They are generally exposed to view and are laid indiscriminately over the body of the host, although the species appears to have a decided preference for the long hairs investing the inside of the fore-legs.

Hatching.

The conditions favourable to the hatching of the eggs are not alike for all three kinds. Our experiments demonstrated that those of *intestinalis* require moisture and friction, and we were thus able to corroborate the work of Osborn.

The eggs of *nasalis* and *haemorrhoidalis* hatch freely in the absence of both moisture and friction.

Newly-Emerged Larvae.

The larvae can be easily and readily distinguished in the first stage by differences in the arrangements of the spiny, segmental armature and by the spiracles. In *nasalis* there are but 12 segments in contra-distinction to the thirteen of the other two, and this species also bears rather elongated slender hairs.

Some experiments were carried out by Dr. Hadwen and the author, (*loc. cit*). in which the ability of the newly-hatched larvae to penetrate animal tissue was tested. Most success was obtained in the case of mucous membranes taken from horses and a calf, the tissues being removed from animals recently killed. It was demonstrated that the larvae will penetrate the buccal mucosa, especially that of the tongue, where they apparently find conditions most suitable for their burrowing activities in the fossae of the fungiform papillae.

It is not unlikely, in this connection, that the scabby pimples, which are to be found on the lips and inter-maxillary space of horses, are respectively due to the direct penetration of the larvae of *haemorrhoidalis* and *nasalis*. This requires confirmation; but the parallel condition, which one finds at the places of penetration of warble-fly maggots in cattle, lends support to this hypothesis.

Control.

So far as internal remedies are concerned, veterinarians generally administer turpentine in four-ounce doses, the doses repeated three or four times. After the last dose, the animal is given one ounce of powdered aloes.

To protect horses from oviposition, it is recommended, where possible, to keep the animals stabled during the day and allow them to roam at large at night.

Careful grooming and a discreet use of the curry-comb will serve to remove eggs from the animals' coats. To kill the grubs inside the eggs, the application of kerosene, benzine, or gasoline is effective. As, however, the egg cases continue attached to the hairs after the grubs have hatched, it is not always easy to distinguish with the naked eye whether the eggs have hatched or not. Apart from the removal of the very minute lid, the hatched egg appears exactly like the unhatched to the inexperienced. Therefore, the removal of the eggs in grooming, either with the curry-comb or with a sharp razor or clippers, will prove most satisfactory.

In order to protect working animals against the flies when they are laying their eggs, many farmers have adopted fly nets. These are made of cords fastened

together and dangling loosely on each side of the animal. These nets are quite satisfactory in warding off *G. intestinalis*, which, as has been stated, is not particular as to the region where it strikes. For *haemorrhoidalis*, western farmers generally protect their horses' noses by a wire-screen muzzle, which has the disadvantages of being clumsy and also of interfering with respiration. A nose-band of leather, cut into strips of about three-sixteenths of an inch wide and buckled on to the head-stall so that the strips hang down loosely, will nonplus the attacks of *haemorrhoidalis* as it "strikes" up from below. By attaching a canvas flap from the nose-band to the throat, it will be found that the animal is amply protected against *nasalis*.

References.

1. Curtice, C. The Larvae of *Hypoderma bovis*, DeGeer. Insect Life, v. 2, Jan. and Feb. 1890, pp. 207, 208. The Ox-warble of the United States. Jour. Comp. Medicine, v. 12, 1891.
2. Schaupp, F. G. *In* "The Ox Bot in the United States," by C. V. Riley. Insect Life, vol. IV, p. 306, 1892. Schaupp is the anonymous observer referred to by the author. See, Hadwen Jour. Econ. Ent., vol. X, No. 4, p. 447, 1917.
3. Carpenter, G. H., Hewitt, T. R., The Warble-flies. Fourth Report on Experiments and Observations as to Life-history and Treatment. Jour. Dept. Agr. & Tech. Instr., Ireland, vol. 15, no. 1, pp. 105-132.
4. Hadwen, S. Warble-flies, the Economic Aspect and a Contribution on the Biology. Bull. No. 16, Health of Animals Branch, Dept. of Agr. Canada, 1912.
5. Hadwen, S. The Seasonal Prevalence of *Hypoderma bovis* in 1915. 46th Ann. Rept. Ent. Soc. Ont., 1915, pp. 108-115.
6. Hadwen, S. A Further Contribution on the Biology of *H. lineatum*. Bull. No. 21, H. of A. Branch. Dept. of Agr. Canada, 1916.
7. Hadwen, S. and Bruce, E. A. Observations on the Migration of Warble Larvae through the Tissues. Bull. No. 22, ibid., 1916.
8. Hadwen, S. and Bruce, E. A., Anaphylaxis in Cattle and Sheep Produced by the Larvae of *H. bovis*, *H. lineatum* and *Oestrus ovis*. Jour. Amer. Vet. Med. Assoc., vol. 4, n.s., Vol. LI, No. 1, pp. 15-41, 1917.
9. Clark, Bracy. Observations on the Genus *Oestrus*. Trans. Linn Soc., London, 1797, vol. 3, pp. 289-329.
10. Clark, Bracy. An Essay of the Bots of Horses and Other Animals. London, 1815.

11. Clark, Bracy. Of the Insects Called *Oestrus* by the Ancients. Trans. Linn. Soc., London, 1827, pp. 402-411.

12. Clark, Bracy. An Appendix or Supplement to a Treatise on the *Oestri* and *Cuterebrae* of Various Animals. Trans., Linn. Soc., London, 1848, vol. XIX, Pt. 2, pp. 81-94.

13. Osborn, H. Insects Affecting Domestic Animals. Bull. No. 5, n.s., Div. Ent., U.S. Dept. Agr., Washington, 1896.

14. Ormerod, E. Observations on the Warble-Fly, or Ox Bot-Fly. Third Ed., London 1885. Rep. on Injurious Insects for 1884.

15. Wasburn, F. L., Diptera of Minnesota, Agr. Exper. Sta., Entom. Div., Bull. No. 93, 1905.

16. Bishopp, F. C. The Distribution of the Nose-fly and other Species of *Gastrophilus* in the United States, Psyche, Vol. XXIV, No. 6, pp. 182-187.

17. Hadwen, S. and Cameron, A. E. A Contribution to a Knowledge of Bot-flies. In press.

18. Parker, R. R. Notes Concerning *Gastrophilus haemorrhoidalis* L. (Dipt). Jour. N.Y. Ent. Soc., vol. XXIV, No. 4, pp. 253-255, Dec. 1916.

INCREASED CROP PRODUCTION—A SYMPOSIUM. THE DUTY OF THE HOUR

(For this Society and Every One of Its Members)

By George Maheux, Provincial Entomologist.

The present situation presents a great variety of angles and points for discussion: it is not my intention to give here an analysis that would, moreover, be necessarily incomplete. I simply want to draw attention to one fact, one only, but probably the most important, to bring out an essential problem for the world, and to conclude by pointing out the means at our disposal of meeting the crisis and of solving the problem.

I—The Situation.

First, the fact: It is simple, it is brutal, and everybody admits it except the wilfully blind. The army of consumers threatens to overrun the producers; the equilibrium seems broken on this side and the world is proceeding towards starvation. The fate of our armies, our own fate, depends on the readjustment between production and consumption. We have to choose between two opposite things: starvation, defeat and ruin or increased production, victory and prosperity. In this alternative, the people of Canada have made a choice which is all to their honor; they maintain that the task entrusted to them is not too heavy, and they are determined to bring it to a satisfactory conclusion. Governments and individuals evidently realize the situation, and this fact is an essential element of success. Everybody is desirous of providing the armies with another sinew of war, bread: the soldier's ration.

II—The Increased Production Campaign.

In our Province, the honourable Minister of Agriculture has taken the necessary steps to encourage and stimulate particularly the production of nutritious food substances necessary to fighting men: pork, wheat, and beans.

The organization has already shown itself equal to the task and success is assured. Quebec will supply all the bread required by her population; Quebec will furnish to the Allies a considerable surplus of all these products as well as butter, cheese, etc.

But the Government will go further in the matter. Its desire is that the Province may grow fruits and vegetables not only for home consumption but

also export as large a surplus as possible to relieve the scarcity in the countries at war. Every effort will be used to promote and manage vegetable gardens in towns and villages, and also to have the farmers increase to a considerable extent the area of vegetable crops.

In every way our farmers, villagers and citizens will increase their production to the utmost.

III—Our Role in this Work.

But in this national work, in this eminently humanitarian work, what is the role devolving upon our society, upon us, entomologists and pathologists; in a single word, upon all those interested in the protection of plants?

Can we help in increasing the production? To ask the question is almost to give the answer. If we only take the necessary trouble it will be an easy matter to increase the yield of certain crops (particularly fruits and vegetables) from 10 to 25% in excess of what the grower is already determined to do.

It will only be necessary for this purpose to convince the farmer that his crops will be larger and of a better grade if the plants are efficiently protected against enemies of all kinds which threaten them. It will be sufficient to get him to act with this conviction in mind. Moreover, it will be necessary to acquaint him with the insecticides and fungicides to be used and how they should be prepared and used; finally, it will be a wise thing to help the grower in the purchase of the weapons necessary to fight the parasites of his crops.

How shall we effect this end? We may look upon this question both as a Society and as individuals. Through its influence and work our association may help considerably in this movement. Its action may take the form of a publicity campaign through the press or with posters. It may again be felt through such steps as hints to agricultural societies, clubs, associations, etc. Its influence may be used in asking privileges from the authorities and in pointing out the line of conduct that will benefit the whole country.

Individually, the members of this society can, when circumstances offer, lend a strong hand to the society:

1. By setting an example, which is the best means of convincing people. To a great many of us it will be quite an easy task to cultivate a small garden where all measures of protection will be put into practice.

2. Each member should endeavor to assist the society's action by distributing to his friends all necessary information such as pamphlets, circulars, bulletins.

This campaign, our campaign I should say, must start immediately, and it must be pursued with energy and persistency to the end. It will be a lesson bearing

the best fruits. I know personally that it is rather difficult to convince the farmer that he is making an advantageous investment in spraying his crops; but once he has experienced it, we can rest assured that he will continue to act in a similar manner and this to his greatest benefit.

For its part the Department of Agriculture intends to take advantage of such a favourable opportunity to work along the same lines and to popularise with all the means at its disposal practical methods for the protection of the crops. To this end, the following course will be followed:

1. The widest publicity will be resorted to in order to draw the attention of all concerned to this point and to instruct them in a practical manner through:

(*a*) Daily or weekly newspapers.

(*b*) Agricultural and periodical reviews.

(*c*) Circulars to societies and clubs and

(*d*) Posters distributed in all rural centres.

2. In order to instruct farmers with regard to necessary spraying and how the spray should be prepared and used, the Department will appeal to them by:

(*a*) Lectures delivered by district representatives and others.

(*b*) Demonstrations on the ground with the necessary outfits, and

(*c*) Short and concise bulletins on the subject.

3. The Department will give efficient assistance to members of societies, city garden associations, and in school gardens and fruit-growing centres by:

(*a*) Placing in several districts instructors and sprayers.

(*b*) Co-operating with the Federal Entomological Branch in rejuvenating orchards which the latter undertakes to attend.

(*c*) Purchasing for subsequent supply to growers the required insecticides and fungicides.

4. Finally, the Department will encourage individuals by:

(*a*) Having horticultural instructors visit their crops at home.

(*b*) Premiums to reward the winners of crop competitions.

In this manner, we believe that increased production in Quebec is an assured fact and that parasites (insects or diseases) will be efficiently controlled during the summer of 1918.

HOW MAY OUR SOCIETY HELP CROP PRODUCTION?

By Prof. W. Lochhead, Macdonald College

This question is undoubtedly a proper one at the present juncture. I believe we can be of valuable service if only we can be properly organized and utilized.

Prof. Cooley in his presidential address in Pittsburg before the Association of Economic Entomologists said : "In the present great emergency we must be willing to do anything necessary within our power to increase the supply of plant and animal products, and we should be willing to lay aside for a time our research work and meet emergencies.

At this time there is a special danger from insect and fungous pests because the energy of the producers is centered on production, and there is a general slackening in the efforts for protection on account of scarcity of labor and the high cost of insecticides and fungicides.

Crop protection means increased crop production, but we all know that with the large number of pests of different habits feeding on different plants the methods employed will necessarily be many. They may be grouped, however, under two general headings: 1. *Cultural and preventive* methods, and (2) *Artificial or remedial* methods. Under the first heading will fall all practises of handling the soil for crops that interfere with the development of the pest, such as *rotation of crops, good cultivation, co-operative measures* and the *utilization of the enemies* of the pest as far as possible. It is not necessary to illustrate here how such practises control many of the worst pests. Suffice it to say that such methods are most effective against pests of the ordinary farm crops.

Under the second heading will fall the *application of chemicals*, powder, liquid, or gas, against the pests when they appear, and the use of *protectors, repellants, traps*, etc. It is obvious that an intimate knowledge of both pest and remedy is required if control is to be secured, and herein lies the value of this Society and its individual members.

How the Society may help.—The following suggestions are made tentatively, with the hope that they may be considered seriously.

(*a*) All of our members who are available for rendering assistance should be organized into a *unit* for effective work under the direction of the Provincial Department or the Federal Department.

(*b*) Each member should be assigned work according to his special qualifications. This may be:—

1. *Scouting work*—to keep in touch with threatened outbreaks;

2. *Control work*—to see that proper remedial methods are applied, where outbreaks have already occurred: or

3. *Publicity work*—to prepare circulars and articles for the newspapers, and to give addresses, regarding the nature of the pests likely to appear and the best methods of control.

The work thus outlined obviously implies a director who keeps in touch with all the workers. It also implies a certain amount of equipment for which each worker should be supplied by the Department. The services of the County Demonstrators should be enlisted, as far as possible, for they have an intimate knowledge of the agricultural conditions of their districts, and are in a position to give timely intimations of outbreaks.

Preventive measures should be emphasized. Such measures, as I have already said—rotation of crops, and good and clean culture—can be used to good advantage in the case of farm crops. Even if they do not produce apparent results the first year their value becomes more striking in subsequent years. This war is not yet over and were it to cease tomorrow the need for greater production will be felt for years. I believe that if a vigorous campaign were carried out against pests, the indirect results would even outweigh the direct in the general adoption of practises which mean better farming.

What pests are likely to be troublesome this coming season?

1. We will likely have those pests that are more or less troublesome every year, namely the Colorado beetle, the late blight, and the soft bacterial rot on potatoes; the anthracnose and the bacterial blight on beans; the green worm and the root maggot on cabbages; cutworms on garden vegetables and other crops; the flea-beetle on turnips; the cucumber beetle on melons, cucumbers and squash; the codling worm, bud moth, curculio, aphis and scab on apples; the currant worm on currants and gooseberries; smut and rust on oats and wheat; and others of minor importance.

2. There may be a recurrence of certain forms that appear periodically, such as grasshoppers, the wheat midge, the clover seed midge, white grubs, and the tussock worm. It is improbable, however, that grasshoppers will be serious, but there is a probability that the wheat midge and the tussock worm may do some injury. *Forewarned is to be forearmed;* consequently the first duty of the farmer, fruit-grower and gardener is to equip themselves with the necessary chemicals

and supplies so that they may be able to prevent the appearance of the pests or to control them when they make their appearance.

The second duty lies with the Department through this Society, perhaps, in providing needful information for the control of the pests in printed form for every County Demonstrator, every school, every farmers' organization, every newspaper, every clergyman, and every mayor, so that as many persons as possible may be reached. But it is not sufficient to hand out printed information only. It is necessary to have a body of scouts who are acquainted with the pests so that proper methods may be applied. If it is worth doing at all it is worth doing well. Unfortunately we have not a large number of ready-made scouts, but such men could be trained in a short time for their work.

SOME INJURIOUS INSECTS OF STE. ANNE DE BELLEVUE, 1917.

By P. I. Bryce, Macdonald College.

Insects Affecting Grains and Clovers.

The greater wheat stem maggot (*Meromyza americana*) caused considerable white head injury in wheat and barley. About July 25th to 27th the fly had changed from a pale green maggot ¼ in. long, legless and smooth, but with two black rasps on the smaller or head end. The puparium is formed from the last larval skin but shows less signs of the segments. Both stages are found between the upper mode or joint and the head, generally under the sheathing leaf, inside the hollowed out stem. By August 8th, the adult emerged as a small greenish metallic fly, with three black bands on the thorax.

The Hessian fly (*Mayetiola destructor*) did some damage to spring wheats. The characteristic bent stem, partly ascending again, and usually short, was found. The plants often showed much tillering with 5-6 or more stunted heads.

Corn showed damage to the leaves ressembling that caused by the corn bill-bug (*Sphenophorus inequalis*).

Insects Affecting Root Crops and Vegetables.

Considerable injury to cauliflower and cabbage was done by the cabbage root maggot (*Chortophila brassicae*). Where card-board discs were placed about the plant, when planted, no maggot injury was done.

The onion root maggot's work was noticeable, but the damage was not considered serious. It is probable that a careful examination would show a greater loss than is thought.

Flea beetles were especially injurious to the potato crop, while damage was done to turnips, beets, horse radish, willow, currant, choke cherry, and grape. The potato flea beetle (*Epitrix cucumeris*), *Crepidodera helxines* on willow, the horse radish flea beetle (*Phyllotreta armoraciae*), turnip flea beetles (*P. sinuata and P. vittatta*), the grape-vine flea beetle (*Haltica chalybea*) and the hop flea beetle (*Psylliodes punctulata*) were taken during the month of June. Colorado potato beetles were abundant, but were controlled by the poison Bordeaux spray. The predacious pentatomid or stink-bug (*Perillus sp.*) was found in some numbers feeding on young beetles.

To those raising parsnip seed, some loss was caused by the greenish, black-tubercled parsnip web-worm (*Depressaria heracliana*). It feeds on the flower

heads and spins a loosely-webbed nest, containing several caterpillars. The narrow brownish forewings of the moth which emerged August 6th are pencilled with black, the hind wings are a gleaming silvery gray, and rather long-fringed. The zebra caterpillar (*Mamestra picta*) was unusually common on succulent weeds in the fall, but vegetables seemed little attacked by it. There were but few striped cucumber beetles (*Diabrotica vittatta*). The 12-spotted and the steel-blue asparagus beetles (*Crioceris asparagi and C. 12-punctata*) were fairly common.

Insects Injuring Orchard Fruits.

Codling moths (*Cydia pomonella*) emerged in late June and early July. Probably for this reason the apple worms were not able to enter the blow or calyx end, and much "side-worm" injury was done to the surface of clusters of apples.

The salt marsh caterpillar (*Estigmene acraea*) is a "woolly bear" of changing and variable color. At first gregarious, tiny blackish caperpillars skeletonize the leaves; then shedding their black for brownish or reddish hairs they wander about and feed according to their fancy as on bean pods. The moths are white winged with black dots. The males' hind wings are yellowish.

The white-marked and antique tussock moths (*Hemerocampa leucostigma* and *Notolophus antiqua*) were destructive to shade and fruit trees. Eggs and pupae were attacked by parasites.

The leaf crumpler (*Mineola indiginella*) attacked the unfolding apple leaves in small numbers. Its peculiar dangling winter case resembles a withered leaf stalk, while its grayish spring feeding-case is in shape like a ram's-horn trumpet.

Both the eggs and female moths of the half-winged Geometer (*Phigalia titea*) were taken on April 30th on Silver Maple. The stubby short-winged females are flightless. The span worm larvae are black, with flesh colored mottling and stripes.

Cigar-case bearers (*Coleophora fletcherella*) were abundant on apple.

The yellow-necked caterpillar (*Datana ministra*) fed in large groups on apple and service-berry (*Amelanchier*).

Abundant egg-punctures of the buffalo tree hopper (*Ceresa bubalis*) scar the branches of various shade and orchard trees.

Insects Affecting Currant, Gooseberry and Raspberry.

The raspberry saw-fly (*Monophadnus rubi*) was slightly harmful on leaves. The imported currant borer (*Sesia tipuliformis*) was collected but is less harmful

than the imported currant sawfly (*Pteronus ribesii*). Some damage was done by the currant span worm (*Cymatophora ribearia*) especially on the flowering currant (*Ribes cereum*).

Insects Affecting the Grape.

The worst pest of the grape, the leaf hopper or grape thrips (*Typhlocyba comes*), undoubtedly reduces the yield appreciably. The little hoppers are unable to jump like their older fellows and succumb if hit by the nicotine sulfate or "Black Leaf 40" spray, 1 to 100 of water. A good pressure is necessary and the under side of the leaf should be hit by the spray. The old hoppers winter over in near-by sod and weeds, hence clean farming helps much to control them.

Insects Affecting Shade and Forest Trees.

Less common at Ste. Annes than at other points were the unsightly nests of the fall web-worm (*Hyphantria cunea*). The ash (*Fraxinus sp.*) was attacked severely. The hairy caterpillars are yellowish or grayish, with a broad blackish stripe along the back.

The poplar saw-fly (*Trichiocampa viminalis*) did some damage to the Carolina poplar, where the yellow, black-dotted caterpillars worked among the foliage. Then they spin a silken cocoon in the ground, and in late August is seen the small four-winged sawfly with black head and thorax, and straw-yellow abdomen.

The birch chrysomelid beetle (*Caligrapha scalaris*) was bred from soft black grubs feeding on willow.

INJURIOUS FUNGI OF STE. ANNE DE BELLEVUE, 1917

By P. I. Bryce, Macdonald College.

The weather of 1917 during the growing season should be kept in mind while considering the occurrence of the fungi mentioned.

While most of those diseases may be said to be present each year, and some are not specially injurious, under favorable conditions as regards heat, light, air movement and moisture certain of them assume the epidemic form and impair or ruin a crop over widespread areas.

Under the influence of these conditions the crops showed more or less susceptibility to fungi attacking leaves, stems, fruit or the roots, as the case might be.

In alfalfa, of which many varieties were grown, in early July the Leaf Spot caused a loss all the more severe because the leaves are so liable to drop in curing. At the edge of the spots the epidermis is raised and dark brown, but the centre is lighter colored when the pustule bursts. The leaf may be entirely covered with the disease and soon withers.

The Apple Black Rot damaged the fruit of trees on which were Black Rot Cankers and mummied fruit. It is believed that trees sprayed properly are well protected, but cankers following sun scald should be removed, and covered with grafting wax, and all large scars painted with coal tar. Destroy all infected fruit as soon as possible. Weakened apple and plum limbs suffered from the attack of the Schizophyllum bracket fungus. From these limbs it spread to healthy parts. While trees sprayed with lime sulphur suffered little from Scab or Spot fungus, some varieties were hard hit, viz., Takake, Bedford and Martha. On July 21st a brown spot was causing damage to apple leaves, spreading as a circular or irregular area from a brown or sometimes black centre. Later the spots dropped out.

In the European barberry and holly barberry or Oregon Grape the cluster cups of the Black Rust of grain were plentiful. Yellow cluster cups of the Brown Rust of oats were too common on the European buckthorn.

The bean (*Phaseolus vulgaris L.*) crop was very severely damaged by Bacterial Bean Blight, the Anthracnose or "Bean Rust" also caused damage to some varieties of beans, others in adjacent rows being clean. This points straight as an arrow to the fact that seed from infected beans carries over the disease from year to year.

Very little damage to the garden beet was caused by Leaf Blight, the white spots were rarely observed. In storage the roots showed some damage due to a Sclerotinia. The celery beds were quite free from Blight, a remarkable circumstance in such weather as we had.

MEAN TEMPERATURE (F) AND PRECIPITATION FOR GROWING SEASON, MACDONALD COLLEGE, STE. ANNE DE BELLEVUE, QUE.

Year	April			May			June			July		
	Max.	Min.	Ppn.	Max.	Min.	Ppn.	Max.	Min.	Ppn.	Max.	Min.	Ppn.
1917	46.2	31.9	1.79	57.04	49.0	2.82	69.7	53.2	4.885	80.1	62.9	2.51
Means for years 1906-16	49.6	36.7	1.768	65.6	44.0	3.28	74.5	54.0	2.343	81.4	59.1	2.085
Variation of 1917 from mean	− 3.4	−4.8	+ .022	− 8.6	−15.0	−0.46	− 4.8	− 0.8	+2.542	− 1.3	+ 3.8	+0.425

Year	August			September			October		
	Max.	Min.	Ppn.	Max.	Min.	Ppn.	Max.	Min.	Ppn.
1917	77.7	59.0	7.095	64.9	45.8	1.27	49.5	36.1	4.655
Means for years 1906–16	77.4	56.7	2.849	68.8	48.9	3.19	55.9	40.2	2.263
Variation of 1917 from mean	+ 0.3	+ 2.3	+4.246	− 3.9	− 3.1	−2.92	− 6.4	− 4.1	+2.392

Red clover was attacked by disease, the Anthracnose, which destroyed numerous plants in early summer. The leaves withered from the tips, while on their petioles and stems appeared longish, sunken areas on which were made out masses of blunt, crescentic spores.

On Indian corn the Smut disease was common.

The fall of the leaves from the red currant was so rapid that by August 30th most of the plants were bare of leaves. Leaf Spot or Anthracnose was the cause here. It forms very abundant small brown spots on both sides of the leaf.

The European Currant Rust was very common on black currant, where it occurred mixed with the leaf Spot (*Septoria*).

Downy Mildew of the grape leaves and fruit did less damage than in some years. The hollyhock Rust caused severe defoliation and early withering, while the silver maples' leaves on the lawns carried the Leaf Blotch on Tar Spot, though the damage was slight. Orchard grass was seriously injured by the Mildew.

On pears, both at La Trappe d'Oka and Ste. Annes, leaves and fruit were spotted and cracked by the Pear Scab or Spot. At the former the dust spray was used, at the latter liquid lime sulphur.

The red root pigweed provided the White "Rust" (*Cystopus*) and lamb's quarters the Downy Mildew.

While the plum disease most widespread was Shothole or Leaf Spot, the fruit of the egg plums was in great part spoiled on the trees by the Brown Rot. The disease in mummied fruit left on the trees in 1917 has withstood the hard winter, and germinates a one hundred per cent crop of spores. A careful search in 1917 failed to yield any of the perfect stage of the disease.

Of potato diseases little need be said. Early Blight was collected, as well as Late Blight, on August 31st. Following that date the Late Blight progressed rapidly on the cessation of spraying, eventually killing the tops. The wet fall favored the resultant rot in late crop, but a large proportion of the tubers were free, due to the spraying of Bordeaux and lead arsenate given.

In stored potatoes Fusarium Dry Rot is present, apparently coming after the Late Blight.

The orange-red pustules of the Rose Rust were collected on cultivated varieties, but the hurt is not serious. This rust does not pass to an alternate host.

In rye, Ergot was present to a very slight extent, the sclerotia abundantly germinating without the action of frost.

Soy beans were very considerably affected by a Bacterial Blight of the leaves.

Of tomato diseases the Blossom End Rot was noted, while the Leaf Spot (*Septoria*) was common on September 12th and caused some wilting.

ANTS AND APHIDS.

By Father P. Fontanel, S.J., St. Mary's College, Montreal.

All naturalists who have studied ants or aphids have mentioned the intimate relations existing between these two groups of insects. I am quite ready to admit, with Dr. Howard, that these relations constitute "one of the most fascinating topics in the whole field of nature study." (*The Insect Book, page 265*). Most writers see therein merely the manifestations of a marvellous instinct; there are others, however, who try to deduce a proof for the existence of an intelligence which would do honour to many specimens of the human species.

From the economic point of view the interest lies in another direction. Moreover, I have ascertained that many persons are of the opinion that ants render a real service to the plants. It is therefore worth while to examine the question closely and to record some observations which are convincing and easily checked. Such is the object of the following study.

The plants examined with particular care were: Cineraria sp., Amaranthus sp., Papaver sp., Malus sp., Dianthus sp., Petunia sp., Rosa sp., Cerasus sp., Prunus sp., Cucurbita sp., Acer negundo Linn., Cheiranthus sp.

The observations were made on the following species of aphids: Aphis cardui Lin., Aphis avenae, Rhopalosiphum dianthi, Rhopalosiphum nympheae Lin., Aphis rudbeckiae Fitch., Hyalopterus arundinis Fabr., Aphis mali, Rhopalosiphum lactucae. Kalt.

The determination of the greater number of species of aphids mentioned above is due to the Department of Entomology of Ottawa and more especially to Mr. Gibson and to Mr. Ross. I take the present opportunity to acknowledge my indebtedness.

This is the thesis which I wish to prove: *Ants are injurious to plants through their relations with the aphids; they are far more injurious, the smaller the plants are.*

Entomologists who have studied the insects from the economic point of view could not avoid this question, and yet very few of them have made any definite pronouncement. Mr. L. C. Miall, one of the most precise I know, merely says: "Ants often run about plants which are infested by aphids, and have been seen to attack and drive off the aphis eaters." (*Injurious and useful Insects, p. 157*). This is not a very bold statement, for the ants might protect the aphids in order to prey upon them afterwards at their leisure, just as a lion might protect a lamb from a wolf. Mr. J. B. Smith in *Economic Entomology, p. 127*, goes further "since they are of decided economic importance."

In enunciating my thesis I said that the ants are far more injurious than useful. Are they useful, and to what extent? To what extent are they injurious? Clear answers to those two questions must be given.

I—Usefulness of Ants.

Observation enables us to point out three cases especially, in which the ants may be of service to the plants.

1. The ants while running over the plants, and searching for the honey-like excretions on the aphids, worry them and knock them about. The more numerous they are, the more violent is their action. Sometimes the aphids withdraw their probosces from the plants; sometimes they even move on in search of a quieter spot; moreover while moving along the edge of a leaf or beneath a branch, they are thrown to the ground by ants in too great a hurry to avoid them. The fall occasionally brings about their death, for they may be devoured by their enemies, or trodden upon, or drowned in a pool of water. Even if no untoward accident happen to the aphids, time is required for the changes that take place, and the plant benefits. I admit that there is nothing very extraordinary in all that, but after all one must give even ants their due. When we take into consideration the fecundity of the aphids we must admit that if the ants destroyed some of the first generation in the spring, the service rendered to the plant would be appreciable.

2. The ants keep the aphids captive in the dwellings they have themselves constructed. These stables in which milk cows, to use the expression of Linnaeus, are fed have long been known. I have often seen ants snatch aphids from their favourite plant, and drag them into their underground nests. To judge by their resistance the captives did not look upon the change as favourable; they clung to every object along the way. Further, some of those aphids die before attacking the roots. However difficult the explanation may be, the fact itself is indisputable. Now it is at once evident that this is to the plant's advantage. I am not at present discussing the general question, whether this habit of imprisoning and protecting the aphids in order to derive some benefit from them be more useful to the aphids than to the plant. I am simply pointing out the fact that the aphids during their captivity not infrequently meet with a premature death, and the plant enjoys at least a momentary relief. This ought to cause no surprise, the ant consults its own interests first and foremost, and however marvellous we may consider the instinct which guides it, still from time to time in particular circumstances it may be at fault. Its fallibility increases with the need it has of the aphis. All the instances in which the ant helps the aphids, carries them from one plant to another, and shelters them from the inclemencies of the

weather have been collected with great satisfaction. These operations are wonderful, I admit, but I see no advantage in exaggerating their significance. When vigorous aphids are taken captive and die shortly afterwards I conclude that were it not for the ants they would have lived and pumped nourishment from the plant for a much longer period, and would have multiplied to the plant's detriment. We sometimes see these captives dragged away even from indoor plants before the autumn, when there is no fear of severe weather; therefore either the instinct of the ant is at fault, or else what it is seeking for above all is to have its purveyor within reach. In any case it relieves the plant.

3. The aphis injures the plant in two ways: it withdraws the sap, and it secretes an injurious fluid. This fluid "spreads over the leaves and branches, and by holding the dust and corpuscles floating in the air, blocks up the stomata of the epidermis and often causes the plant to perish." (*Provancher: Le Verger Canadien, p. 41.*) The service rendered to the plant in this case is more direct and I think more important than in the two preceeding cases. However, we must not generalize too much, but rather make some necessary distinctions. Some aphids produce but a small quantity of this sweet liquid; the harm to the plant and consequently the services rendered by the ant are then less appreciable. This is the case, for example, with the aphis rudbeckiae Fitch. As the ants themselves are not numerous they cannot do any considerable damage. When the aphids secrete a considerable quantity of this honey dew two alternatives arise. The aphids are either extremely numerous and completely cover the plant, or are thinly scattered over the branches and leaves. If the aphids be very close together the little drops of the secretion, having no part of the plant to cling to, fall to the ground. At once the service rendered by the ants is considerably diminished. In the second case the drops remain on the plant and the ant is more useful. In both hypotheses there is a sort of compensation: when the aphids are less numerous, the plant suffers more from the secretions; on the other hand, the more numerous are the aphids the more numerous also are the ants, provided other favourable conditions be realized.

To sum up: the ants help the plant in three ways: first, they accidentally bring about the death of the aphids or at least cause a delay in their injurious action; secondly, they keep them in captivity and force them to observe a fast which is sometimes fatal; thirdly, they absorb the secreted matter which might block the stomata.

II—Harmfulness of Ants.

I think I have given the ants sufficient credit for the good they do; a revelation of their misdeeds will not be out of place.

First, truth obliges me to say that any service rendered to the plant is altogether accidental. The facts given above are an implicit proof of this. If the

ant were endowed with reason, I should say that it performs a good act against its will. What it seeks first and even exclusively is its own good, and all its intercourse with the aphids bears the marks of the purest egoism.

It remains for us to see some of the evils which the plant suffers. I shall collect them under three heads: the protection of the aphids; the propagation of the aphids; the isolation of the plant.

1. *Protection of the aphids.* This protection is twofold; from the inclemencies of the weather, and from their natural enemies. The protection against the weather in summer has but little importance; it is otherwise in the spring and autumn. It frequently happens that aphids hatched early in the spring are exposed to death from a late frost, if left on the plant or on the surface of the ground. The ants, however, often drag them into their nests. Here they are sheltered from the cold, and may attack the roots of the plants. In the autumn, the last of the last generation would be frozen before reproduction could take place, were they not interfered with; but thanks to the enforced confinement their complete development is rendered possible. This captivity has another advantage which extends even to the individuals that would have the time to lay their eggs before the frost, namely, the eggs are less exposed and are guarded by the ants when necessary. This brings me to the discussion of the protection from their natural enemies.

Many naturalists have asserted that insects which live on aphids are driven away by the ants. I willingly admit this, but with some restrictions. In the first place, are we certain that this is done in order to protect the aphids? It may well be that the ant is merely taking precautionary measures to avoid an attack which it believes is directed against itself. This hypothesis, I think, may enable us to interpret many of the facts, and moreover it affords an explanation of the mania for imprisoning aphids in the middle of summer. Further we must not confuse a double flight with the pursuit of a fugitive. An ant at the top of a plant suddenly perceiving an insect climbing up, and attributing evil intentions to it, will hasten to descend; the insect fearing for itself will retreat, and we have thus two fugitives hurrying in the same direction.

Everything happens as if the ant were in pursuit of a fugitive insect. I was able to witness this spectacle by forcing a harmless insect up the plant. If the insect be carnivorous and of respectable size the ant does not wait for it to manifest its intentions. The following is a convincing proof that we must not exaggerate the courage of the ant. I took some ants living among the aphids of the apple tree and placed them on plants infested by the Rudbeckia aphis. They moved about slowly at first, but as soon as they met the aphids there was an indescribable panic; in most instances indeed they threw themselves to the ground to escape more quickly. Yet what could cause them less injury then an aphis? We must not

conclude that the ant never chases away the enemies of the aphids; too many authors hold the contrary opinion and I agree with them. Exaggeration, however, must be avoided.

It is difficult to determine the harm which the ant does the plant by protecting the aphis. But it is certain that this harm more than counterbalances the service rendered in the cases mentioned above. The service rendered is accidental, whereas the injury results naturally from the circumstances. The ant feeling that it is stronger than the enemy of the aphis instinctively gives chase to it and will do so every time it meets it. In spring and in autumn the chase will be more vigorous since the number of aphids is smaller. Now it is precisely during these seasons that this insect might be of the greatest help; in the spring by devouring even in one aphis many generations of aphids, and in the autumn by preventing the production of eggs.

2. *The propagation of the aphids.*—This is to my mind the obscurest point in the history of ants and aphids. Many marvellous facts are recorded by the authors, but I fully agree with Mr. Kellogg's opinion that "most of the stories of ants and aphids printed in popular natural history books need to be tested by careful observation." (*American Insects, p. 175.*) It will be sufficient here to recall one of the best known facts without giving any detailed explanation. The aphis found on the root of maize is hatched before the maize has struck root. The ants take it and place it carefully on the roots of various plants, and there protect it until the maize has germinated, and then they bring it back to its proper abode. This fact, which is perfectly authentic, is a striking example of the harm the ant may do. The same instinct is manifested in another way, which is perhaps more important. Even if the aphids are hatched on their favourite plant they may be transported elsewhere. The ants build their nest near a plant not yet infested, and then go hunting for aphids. They spare no labour and sometimes fetch them to the plant from a considerable distance. In the spring this transportation of the wingless generations is fatal to the plants. Eventually of course the aphids might undertake the journey of their own accord, but it would be longer and much more dangerous, for the ant follows a beaten track and carefully protects its precious burden. Now, the multiplication of the aphids depends to a large extent on the quantity of sap at their disposal. In the spring the sap is very abundant, and if the aphids are scattered over a larger number of plants, they have more and better opportunities for propagation. Hence the harm done is considerable.

3. *The isolation of the plants.*—This is the last part of my thesis: "ants are all the more injurious, the smaller the plants are." In developing my thought I shall use only a few of the numerous facts I have observed.

(*a*) Some *Amaranthus tricolor* and *Amaranthus caudatus* were literally covered with aphids, while a large number of ants ran about in all directions. In

some of the underground galleries beneath the plant aphids were kept. In digging these galleries the ants, either accidentally or perhaps in order to allow the prisoners sustenance, had uncovered the roots and rootlets of the plant. In some cases two-thirds of the roots were thus isloated, and therefore were unable to draw the necessary nourishment from the soil.

(*b*) The growth of some young *Acer Negundo* was very slow although they were planted in good soil. With the exception of some ants that visited them occasionally, they were not infested by insects. These ants, however, seemed to have their nests near the roots. Through curiosity I gently uncovered the roots of some saplings, and great was my surprise when I found them covered with small white aphids. Innumerable ants mounted guard over these lodgers. Here again, either to facilitate travelling or to help the aphids, the ants had laid bare the roots. Thus was explained the slow growth of the maples. The only channels of nourishment left to them were a few roots still embedded in the earth, and the small quantity of sap thus obtained was taken by the aphids.

(*c*) The flowers of the *Amaranthus caudatus* mentioned above droop and trail on the ground. When the aphids swarm over them, the ants pile up the earth around them and bury them. Thus they are cut off from the light and liable to rot. The same will happen to any plant infested by aphids and visited by a number of ants, if the stalk or a branch be bent to the ground.

The reasons why the injury is greater in the case of smaller plants are:

1. The stalk being shorter, the trips from the ground to the branches are more frequent; and hence since the ants spend more time off the plant, there is greater need of underground galleries.

2. The smaller roots are more easily isolated, whereas large roots would be laid bare only on one side.

This will be sufficient, I think, to prove that we must not look upon the ants as useful because of their relations with the aphids; for we have seen that their misdeeds outweigh incomparably the good they accomplish. Therefore they must be prevented from settling near plants which are attacked by aphids, especially if the plants be annuals or biennials. The aphids themselves will certainly not complain for there is nothing to prove that they set a high value on the friendship of the ants; on the contrary the desperate efforts they make to escape from captivity show that a benefit would be conferred upon them by this measure.

[N.B.—This paper was originally written in French. For the translation I am indebted to Rev. F. Downes, S.J.]

THE CONTROL OF THE WHITE-MARKED TUSSOCK MOTH.

By J. M. Swaine, In charge of Forest Insect Investigation, Entomological Branch, Ottawa.

The shade trees of our cities and towns form an asset of enormous value. The beauty of their foliage and the comfort afforded by their shade help to render our cities habitable during the hot summer months.

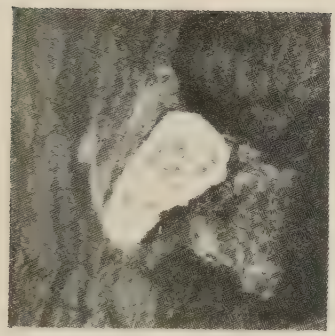
Their value is partly expressed in money in the increased property values. Real estate dealers have estimated the increased property value due to trees on and near residence property at 40% to 100%. Large and fine trees have been valued by competent authorities at from $150 to $500. If the shade trees were entirely removed from a good resident street in Montreal, how would property values on the street be affected? Without any question our city shade trees form an asset worth many hundreds of thousands of dollars, and it is plainly worth while to spend a few thousand dollars in their protection when this is needed. It is unfortunate that our shade trees have been almost entirely neglected in many places until the greater part of them are more or less seriously weakened by boring insects and fungous diseases, and are defoliated by periodic outbreaks of leaf-feeding caterpillars.

In addition to the danger from their insect and fungous enemies the trees have to contend with extremely adverse soil conditions and atmospheric conditions as well as with breakage from wind and ice. Protection against breakage is largely insured by a proper support of bolts and chains.

The control of fungous diseases consists chiefly in excavating all the decayed wood, disinfecting with creosote the clean wood surface thus exposed, and filling the cavity with cement. Scars from pruning or any other cause should be disinfected with creosote and coated with tar, leaving the cut edge of the bark and cambium clean. All dying and dead trees and parts of trees should be removed and burned early in the season before the insects and fungi which they contain can spread to other trees.

The most serious insect injuries to shade trees are caused by boring grubs or caterpillars and leaf-feeding caterpillars, grubs and saw-fly larvae.

The most effective general measure against large wood-boring larvae is to cut out and destroy the young borers with a sharp knife and a wire, or to kill them within their burrows by injecting therein carbon-bisulphide from a small syringe and closing the opening with putty, soap or clay. After twenty-four hours the dead larvae should be removed if possible, the cavities disinfected, and then filled with cement or putty.



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THE WHITE-MARKED TUSSOCK.—1, an egg-mass attached to a cocoon; 2, a caterpillar feeding upon a leaf; 3, the female moth and a freshly deposited egg-mass; 4, the male moth. Figs. 1, 2 and 3 are from Bul. 312, Geneva Agric. Exp. Station.

Defoliating insects are controlled by spraying the infected foliage with lead arsenate as soon as possible after the attack has commenced, or if the time can be estimated, just before the eggs are hatched.

The white-marked tussock moth is an excellent example of our defoliating caterpillars, and an account of its control will be opportune at the present time, since we are threatened with an outbreak of its caterpillars this coming summer. The species is native to this country, and is found on deciduous trees nearly everywhere each season in varying numbers. In the Maritime Provinces and in the region bordering on the St. Lawrence River and the Great Lakes its caterpillars periodically become exceedingly numerous and are recognized as one of our most serious shade tree pests. The last outbreak in Quebec Province ended in the summer of 1911. The white-marked tussock is frequently injurious in orchards, and destroys the young fruit in addition to defoliating the trees.

Description of the Insect.

The Adult.—The two sexes of the adult stage are strikingly different in appearance. The *male* is a beautiful greyish moth, about an inch and a half across the wings when spread, with tufted legs, feathered antennæ, and transverse wavy lines across the fore wings.

The *female*, on the other hand, is a very stout and clumsy creature, greyish in colour, almost without markings, and nearly wingless. She usually crawls upon the cocoon from which she has emerged, and after pairing deposits there her mass of eggs, and dies.

The Eggs.—The eggs are deposited in masses containing from one hundred to five or six hundred; one egg-mass is laid by each female, usually upon the empty cocoon. The mass of eggs is covered by a thick layer of white frothy fluid which hardens rapidly, and, in addition to holding the eggs together, protects them from adverse weather conditions, and in some measure probably from their enemies. The individual eggs are small, whitish, and nearly spherical. The egg-masses of the closely related rusty tussock moth are laid bare upon the cocoon, without the frothy covering, and are thus easily distinguished from those of the White-marked Tussock.

The Caterpillar.—The length, when full grown, is slightly more than an inch. The colours are in longitudinal bands, more strongly marked behind, yellow below, greyish on the sides, with a bright yellow, subdorsal band above on each side of a median black band. The median dorsal line bears four prominent white or yellowish brushes of hair, one on each of the first four abdominal segments, and a small coral red tubercle on each of the sixth and seventh segments. The

head and the upper part of the first thoracic segment are bright coral red. Two long black pencils of plumed hairs project from the sides of the first thoracic segment over the head, and a similar pencil upwards and backwards from the median line of the eighth abdominal segment, the twelfth including the head. The body is sparsely clothed with long, greyish hairs arising in radiating tufts from yellowish tubercles.

The rusty tussock caterpillar differs in being less brightly coloured and in having a pencil of long black hairs on each side of the fourth segment behind the head.

The Pupa.—The adult caterpillars spin greyish silken cocoons attached usually to the bark of tree trunks. Within the cocoon the caterpillar changes its skin and appears as the chrysalis. The male chrysalis is brown or nearly black, and sparsely clothed with greyish hairs; that of the female is much larger, without the distinct wing cases, and has a transverse patch of light-coloured scales across the back of each of the first three segments behind the head. The cocoon of the female is tougher and darker in colour than that of the male.

The Life-History and Habits.

The winter is passed in the egg-stage in the white conspicuous egg-masses, attached usually to the cocoons. Normally the egg-masses are deposited upon the trunk and the under side of the larger branches, but in seasons of great abundance they occur in considerable numbers in the upper parts of the trees and upon nearby objects, such as fences and buildings.

The eggs hatch usually during the month of June. In very early seasons in the district about Montreal, some egg-masses hatch in the last week of May, and the greatest activity in hatching is in the first half of June; in late seasons the greatest activity in hatching is in the last half of June, and many egg-masses remain unhatched until early in July. The species, therefore, remains in the egg-stage for practically ten months, from about the end of July until the following June, and a long period is offered for control by the removal of the egg-masses.

The young caterpillars spread somewhat over the foliage, and feed individually on the under surface of the leaves, dropping by means of a thread of silk when disturbed. As they increase in size the wandering habit becomes more marked, and they devour the greater part of the leaf, seriously or completely defoliating the trees when their numbers are great. They complete their growth in from four to six weeks. Many of the large caterpillars wander about freely from tree to tree, so that trees which have been previously clean may become very badly invested by them. The older caterpillars are thus distributed locally

by these wandering habits. It is probable that the small caterpillars, when suspended on the silken thread, may be carried considerable distances by winds, and the infestation still further extended in this way. When the caterpillar becomes full grown, during July or early in August, it comes to rest, normally upon the trunk or larger branches, but during an outbreak, upon any part of the tree or upon neighbouring objects. Here it spins a greyish cocoon composed of silk and hairs from the body firmly attached to the bark or to the object upon which it rests, and within this it changes to the chrysalis or pupa. About ten days or two weeks are passed in this condition, and then the adult moth appears from the cocoon. The wingless female seldom moves away from the cocoon out of which she has emerged; usually she crawls upon it, and after being fertilized by a male and depositing there her whitish egg-mass, dies and usually falls to the ground. The male caterpillars cease feeding and spin their cocoons earlier than the females, and produce distinctly smaller chrysalids.

There is only one brood annually in Quebec Province.

The Injury.

The extensive defoliation by the caterpillars destroys the beauty of the trees for much of the season, and often injures them so seriously that branches either die outright after repeated attack, or become so weakened thereby that they gradually succumb to injury by other insects such as borers, and fungi.

The list of trees attacked by the white-marked tussock includes a large number of our deciduous shade trees, and even a few conifers. In Eastern Canada the favourite food trees appear to be willow, birch, horse-chestnut, basswood, elms, maples, poplars, and fruit trees.

Natural Enemies.

This species has a very large number of natural enemies. Minute hymenopterous parasites breed within and destroy the eggs, a large number of hymenopterous and dipterous parasites kill the caterpillars and pupæ, and various predaceous insects also aid in reducing their numbers. Certain fungi and bacteria which spread rapidly in epidemics, destroy great numbers of the caterpillars, and are sometimes a chief agent in their control.

The last outbreak of the white-marked tussock in Eastern Canada, as already mentioned, extended from Halifax to Western Ontario, and lasted, in all, from 1903 to 1911. It was not anywhere abundant throughout the whole period, however, and was brought finally and suddenly to a close by the action of parasites and fungi. The species has bred in obscurity since that time, and is

just now coming again into prominence, since the scarcity of its parasites has allowed it to breed to such great numbers. Eventually they will again effect its control, in time probably to save the life of the trees, but not soon enough to prevent much injury in addition to the disfiguration of the trees during the summer.

A few of our native birds feed upon hairy caterpillars such as the white-marked tussock, and are important factors in natural control in sections where they are still numerous. Unfortunately, man and the English sparrow have united to drive these useful birds away from the neighbourhood of our cities, towns, and larger villages, with the result that the white-marked tussock and other destructive insects find our centres of population more acceptable to them than the open country. The protection and encouragement of our insectivorous birds is a most important method of insect control.

Control Methods.

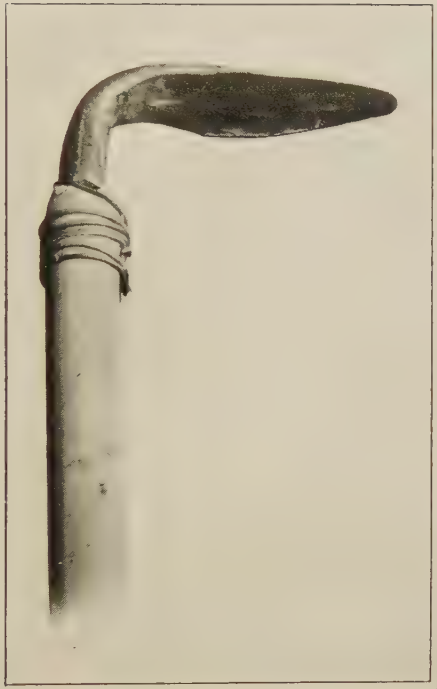
One of the most important methods of preventing serious insect injuries is found in the provision of the best possible conditions for tree development. Proper surgical treatment to remove rot infections and fill the resulting cavities, and to support the weakened parts with cement, iron bolts and chains, so as to prevent breakage, as well as the provision of abundant water in dry seasons, and general precautions against injurious insects, help the trees to a vigorous condition that withstands more successfully the severe periodical insect outbreaks.

The life-history of the white-marked tussock discloses two periods, the egg and the larval stages, during which control measures may be successfully applied. The eggs may be destroyed, and the caterpillars may be killed by poison.

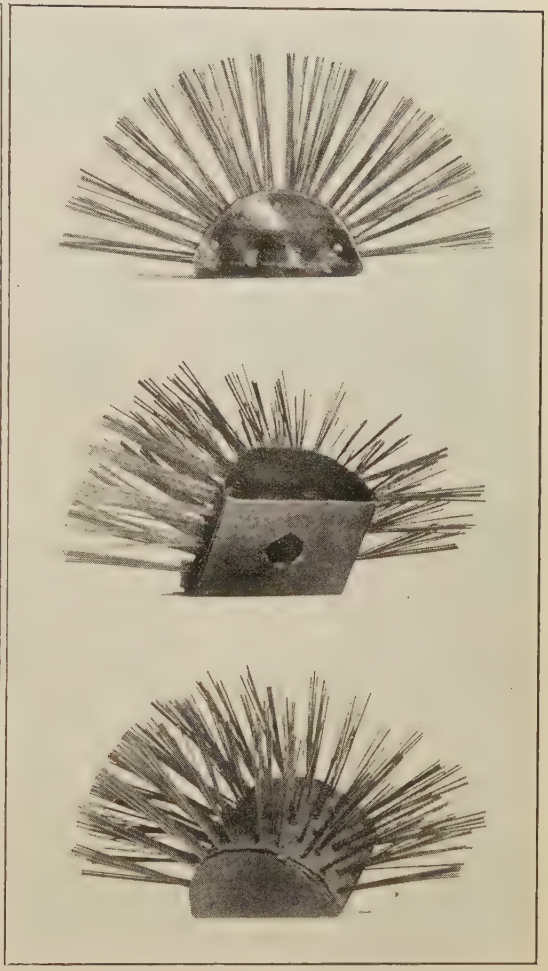
The Destruction of Egg-Masses.

The more effective and economical method for application in cities and towns is usually considered to be the destruction of egg-masses during the dormant season, combined with banding the tree trunks. Fortunately the white masses are so conspicuous that they are at least easily observed. The species is present in the egg-stage for practically ten months of the year, in this climate, and a long period is thus offered for the removal of the egg-masses.

If the eggs are entirely removed from a group of trees during the fall, winter, and spring, and the trunks are properly banded to prevent reinfestation by wandering caterpillars, the foliage will be completely protected from tussock caterpillars for the season.



Hook or Scraper for removing egg-masses; used by the Toronto Park officials.



Wire Brush for removing egg-masses.

The egg-masses are either killed by painting them with creosote, or removed by means of wire brushes or scrapers.

Painting with Creosote.—The egg-masses may be killed by painting them with creosote by means of a brush. Rubber-set paint brushes are used, attached to light pine poles, about 16 feet long and 1¼ inches square. The creosote is darkened with lampblack so that the painted egg-masses can be more easily distinguished.

The Egg-mass Remover.—A special wire brush, 5 inches long and 1 inch wide, has proven very efficient in removing the egg-masses. A narrow hoe-blade, 6 inches long and 2 inches wide, has also been used effectively. An excellent scraper is used in Toronto for this purpose. It is a short spoon-shaped blade, 2½ inches long and one inch wide, with moderately sharp edges. Saw teeth filed on the edges make it somewhat more effective. The brush or hoe-blade is attached to a long handle; two lengths may be employed, one of 10 feet and the other 18 or 20 feet.

The work of removing or destroying the egg-masses is done usually by gangs of three men each, equipped with an extension ladder, and either egg-mass removers and canvas sheets or creosote outfits, one man directing the work from the ground.

When the egg-masses are removed by brush or scraper, some of them are broken and the eggs are scattered about the ground. Many of these eggs would probably survive and reinfest the trees; and it is therefore advisable to spread large canvas sheets on the ground beneath the trees before the operation so that the eggs may be easily collected, or else to have all the trees properly banded before the hatching time of eggs in the following season.

In collecting the egg-masses, care should be taken not to remove the cocoons which do not bear the eggs. These cocoons contain useful parasites, and they should be preserved; they are easily distinguished from the true egg-masses by their darker colour.

Spraying with Arsenates.

When the egg-masses have not been removed from the trees, and the caterpillars are numerous upon the foliage, it is possible to prevent further injury by spraying the trees with lead arsenate paste at the rate of 5 to 15 pounds to 100 gallons of water. Lead arsenate is better for this purpose than Paris green, since it can be used in stronger solutions without danger of serious injury to the foliage, and it adheres to the leaves for a much longer time. Five pounds of lead in one hundred gallons of water will kill the caterpillars at the time of hatching, 10 pounds

of poison should be used if the caterpillars are more than a few days old, and 15 pounds after they are one-third grown.[1]

The first application should be made, if possible, just before the eggs hatch, or at least as soon as the caterpillars appear; the sooner they are killed the less the injury will be, and also the caterpillars are much less readily killed by poisons after they become one-third grown, or even after a few days' feeding. Their first meal should carry the poison.

After the caterpillars have been killed by the use of poison, the trees may again become infested by the older wandering caterpillars from nearby foliage. While these may actually cause little injury to the foliage, they will spin their cocoons on the trunks and branches and infest the trees for the following season. For this reason it is necessary to band the trunks before the caterpillars begin to migrate.

Banding the Trees.

It has already been pointed out that after the egg-masses or the caterpillars have been destroyed the trunks of the trees should be banded so as to prevent reinfestation by wandering caterpillars. If there is any danger of infestation from hatching eggs on the ground or on objects near the trees the bands should be applied before the eggs hatch, and at the latest they should be in place before the migration time of the caterpillars. The date of hatching varies so widely with the weather conditions of the season that no definite date can be recommended, but the bands should usually be in place by the middle of June, and in some seasons before that time.

Tree Tanglefoot.—Several devices for preventing the caterpillars climbing the trees, such as bands of cotton, burlap, metal and various sticky substances, have gradually given place to the sticky mixture known as "Tree Tanglefoot," which may be obtained in bulk from any dealer in insecticides. *A fair substitute may be made by boiling together equal parts of castor oil and resin.*

The tanglefoot is applied with a wooden paddle so as to form a complete ring about the trunk, 4 inches wide, from 5 to 8 feet from the ground. Before the mixture is applied the surface of the trunk on which the application is to be made should be scraped unless the bark is already sufficiently smooth. The tanglefoot gradually hardens on the surface, and it is therefore advisable to break its surface by scraping it over with a coarse comb at intervals of ten days or two weeks. Instead of applying the tanglefoot to the bark it may be spread upon a strip of canvas or burlap fastened around the trunk.

[1] The powdered form of lead arsenate is used at one-half these strengths.

While the trees are being banded, any connections with infested locations should be broken. Telegraph wires or branches interlocking with infested trees may reinfest the clean trees after all ordinary precautions have been taken; and it is therefore necessary to band telegraph and telephone poles whose wires have any connection with the shade trees to be protected, or to cut out with trimmers the branches which connect with the sources of infestation.

Spraying Outfit.—For spraying city shade trees effectively it is absolutely necessary to have an efficient spraying outfit. A power sprayer is required, capable of giving from 400 to 600 pounds pressure, and with a pump capacity great enough so that a solid stream may be held constantly from 65 to 85 feet up from the nozzle. These requirements should be insisted upon when purchasing spraying outfits for shade-tree work.

THE USE OF CHEMICAL SPRAYS FOR COMBATTING WEEDS.

By J. Adams, M.A., Botanical Div., C.E.F., Ottawa.

That the problem of weeds is a burning question in the Province of Quebec as it is in most other parts of Canada will admit of no doubt whatever. A recent correspondent in a letter dated 11th August, 1916, writes as follows:—"This summer at Franklin Centre, Quebec, I employed part of my vacation exploring the plant life of the district and was much interested in the number of weeds found there. I found forty different varieties along the road side in a distance of not more than a quarter of a mile, not counting small chickweeds, etc.; I found there a Goatsbeard which I had not seen anywhere else in Canada. It seemed to be causing a good deal of annoyance to several of the farmers."

While it is probable that the hoe and the cultivator will always remain as the principal weapons to employ in the fight with weeds, still any other aids that may help to make the fight more favorable for the farmer are always to be welcomed. One of these auxiliary forces is to be found in chemical methods. So long as extravagant claims are not made for them and so long as they are used in their proper place chemical sprays are likely to play a useful part in farm economy.

It may happen that a grain crop is badly infested with some weed where the only alternatives are hand-pulling of the weed or allowing it to go to seed. Hand-pulling is in most cases quite impracticable owing to scarcity of labor; if, however, the weed can be so damaged (although not killed) by the use of some spray that the formation of seeds is prevented and the grain plants are given more space to mature, the gain to the farmer is very considerable.

On land that has been allowed to become very foul with weeds it may in some cases be desirable to apply some strong chemical that will destroy all kinds of vegetation at the same time. If this is done early in the season it may be quite possible to destroy the weed and yet secure a fair return from some of the later-sown crops such as corn or turnips.

There are also numerous plots of waste ground in towns, miles of roadsides all over the country, railroad tracks, and large areas of stony or rocky ground that cannot be cultivated, where the employment of chemical means for keeping down weeds might be profitably considered.

With the exception of some work on dandelions and wild mustard, very little seems to have been attempted in Canada in the matter of experiments to control weeds by chemical solutions. Some few results obtained in the year 1916 at Ottawa are given below; time did not permit the continuation of these experiments in 1917.

Chemical Substances Used.

The more useful chemical substances that have given promising results when applied for the purpose of killing weeds are as follows:—Sulphuric acid, iron sulphate, copper sulphate, common salt, caustic soda, sodium arsenite, carbolic acid, orchard heating oil, and fuel oil.

Sulphuric acid or oil of vitriol. Owing to its corrosive effect on the spraying apparatus this chemical can only be used in a fairly weak solution. The proportions vary from 3 to 10 per cent of acid and the spray is applied at the rate of 60 to 134 gallons per acre. It has no injurious action on wheat, oats, or barley crops. It should be applied when the weed has from 3 to 5 leaves. The solution is effective 3 or 4 hours after application and has a fertilizing effect on the soil.

Iron Sulphate or Copperas or Green Vitriol.—A solution varying in strength from 15 to 20 per cent is usually employed; this strength may be obtained by dissolving 100 pounds of the sulphate in 52 gallons of water, which quantity is sufficient to spray one acre. It has no injurious effect on grain crops or grasses or peas but cannot safely be employed with a bean crop. A 20% solution is too strong to use in a field of flax, considerable injury resulting when that strength is applied to flax 5 inches high. Grain crops should always be sprayed before the plants have "headed" or come into ear.

Copper Sulphate or Bluestone or Blue Vitriol.—This may be used wherever iron sulphate is recommended but in a much weaker solution. From 8 to 12 pounds of copper sulphate are used to 52 gallons of water; 50 to 75 gallons of the solution are applied per acre.

Common Salt or Sodium Chloride.—This is one of the easiest and safest sprays to use. A 20% solution is generally employed; 150 pounds to 60 gallons of water will spray one acre. The chief drawback to the too frequent use of this chemical is that it may permeate the soil to such an extent as to check the growth of other plants before it is finally washed out by rain.

Caustic Soda or Sodium Hydrate.—A 5% solution (2 pounds in 4 gallons of water) is employed but as this chemical is likely to kill all other vegetation it can only be used on waste ground or on ground that is not intended to be used until the chemical has been washed out of the soil.

Sodium Arsenite.—This is used at the rate of 1½ to 2 pounds in 52 gallons of water per acre. It is very poisonous and great care is necessary in its use; the powder is dangerous to health if inhaled.

Carbolic Acid is used chiefly for the destruction of plants growing on waste ground, the strength of solution employed varying from 12½% upwards.

Orchard Heating Oil has been used to destroy wild garlic but it destroys all other vegetation at the same time. The spray should be applied at the rate of 75 gallons per acre and in the form of a fine mist. It is not poisonous and does not injure the soil. If applied early in the season a late crop may be grown. It can be obtained from the Standard Oil Company.

Fuel Oil is useful for killing plants on waste ground or garden paths. After its use the soil remains sterile for a considerable period.

The usual precautions in reference to spraying should be carefully observed; poisonous substances should be handled with great care and should not be used on pastures where live stock are allowed to roam about; the spray should be applied in the form of a fine mist; spraying should not be attempted if rain is expected to fall within 24 hours as much of the spraying solution will be washed off the plants before it has had time to take full effect.

When weeds are growing in a field crop judgment must be exercised in applying a spray of such a nature or such a strength that the crop will not be injured as well as the weed. The amount of injury inflicted by a spray on any plant appears to depend largely on the nature of the external surface of the plant in question as well as on the manner of its growth. Some plants have a smooth or waxy surface to which the spraying solution does not adhere; in such cases no injury follows the application of the spray. In those plants which are most susceptible to the action of the spray the surface is easily wetted by the liquid used. In other cases the ends of the leaves are injured but as the growing parts of the plant are deepseated and thus protected from the action of the spray new leaves are soon formed and the plant recovers.

Weeds, as a general rule, are more susceptible to the action of sprays when they are very young; when they are older the spraying fluid cannot penetrate so readily into the tissues of the plant.

Among plants on which spraying fluids of the ordinary strength have no effect are the following:—Grain crops such as wheat, oats, etc., also grasses generally, both grasses used for hay and weed-grasses such as wild oats and quack grass; stinkweed or penny cress, lamb's quarters, perennial sowthistle and various others which do not occur in the Province of Quebec.

It might be possible to add some gummy or adhesive substance to the spraying solution which would cause it to adhere to smooth-leaved plants but this does not appear to have been tried. A more serious difficulty would probably be the danger of grain crops being injured at the same time as the weeds, but this might be surmounted by spraying when the grain is very young when recovery from any injury might be expected to take place in a short time.

Spraying Results at Ottawa.

Before giving a summary of the success achieved by various experimenters in checking different species of weeds by the help of chemical sprays a few of the results obtained at Ottawa may be noted.

The weeds chiefly experimented with were wild mustard, purslane, dandelion, and Canada thistle. The chemical substances used were iron sulphate (20% solution) and sodium arsenite (1 part in 250 of water).

Plot 1.—A small plot of wild mustard in full flower with some pods forming was sprayed with iron sulphate on 24th June. On 26th June not only the leaves but the whole plants were blackened and apparently dead. On 26th July some shoots had grown out from the lower part of the stem and were bearing flowers and young fruits.

Plot 2.—Some purslane plants were sprayed with iron sulphate on 13th July. On 20th July little or no effect was observed as a result.

Plot 3.—A small plot of Canada thistle was sprayed on 29th July with iron sulphate. On 4th August the leaves were considerably blackened.

Plot 4.—A small area of grass on a lawn measuring 10 by 10 feet which was thickly covered with dandelions was sprayed several times during the season with iron sulphate. The first spraying was on 22nd June; on 26th June the greater part of the plot was quite blackened, all the dandelion leaves and white clover leaves being killed.

On 5th July the plot was sprayed a second time and the third application was made on 29th July. A few dandelion leaves had made their appearance between the second and third sprayings. On 31st August there were still a few dandelions surviving which were sending our fresh leaves.

Plot 5.—Part of a path infested with weeds was sprayed with sodium arsenite on 28th June. The principal weed present was *Poa annua L.*, but there was also a considerable amount of dandelion, shepherd's purse, lamb's quarters, *Polygonum aviculare L.*, *Veronica peregrina L.* On 30th June no perceptible effect had been produced.

Plot 6.—A plot of Canada thistle was sprayed with sodium arsenite on 29th June. On 3rd July the plants were all blackened down to the ground level. White clover was all destroyed. On 26th July the thistles were sprouting again at the base of the killed stem.

Plot 7.—A considerable area under hay measuring 8 by 6 yards which was badly infested with Canada thistle was sprayed on 8th July with rather less than

one gallon of Sodium Arsenite solution. The spray was directed chiefly at the thistles present. Other species occurring on the plot were white clover, dandelion, yarrow, tall buttercup, wild strawberry. On 10th July the thistles were quite blackened. One-half of the plot was again sprayed all over with sodium arsenite on 13th July; on 18th July it was observed that not only the thistles but grasses and most other vegetation were killed down to the ground level.

Destroying Weeds by Heat.

Although this method scarcely comes under the title given at the head of the present article, still, as it is so different from the usual methods of destroying weeds, it may conveniently be referred to here.

A burning machine which uses 8 gallons of petroleum per acre has recently (1916) been tried in England. It consists of a number of blow-lamps like those used by painters, which project a very hot flame on to the surface of the ground thus destroying all weed growth. It has been used successfully to clear off the weeds between currants and gooseberries planted in rows.

A somewhat similar idea was last year (1917) put into practice on the Spokane, Portland and Seattle Railway. A locomotive was provided with a series of blowtorches arranged a few inches above the rails. It proved quite efficient in destroying weeds on the track.

Weeds That May be Destroyed By Chemical Methods.

For land that does not bear any crop, taking the question of cost into consideration, the most useful substances will probably be common salt, arsenite of soda, and fuel oil. In the case of shrubby growths if they are sprayed with fuel oil and then sprayed again when the leaves are dry and dead they may easily be set on fire.

A South American railway company uses the following mixture to keep the track free from weeds:—white arsenic 72 grams, caustic soda 15.5 grams, phenolphthalein sufficient to give an intense coloration, water to make up to 100 cubic centimetres. One part of this solution is added to 10 of water and applied by a special apparatus at the end of a freight train at the rate of one quart per square yard. The Columbia and Ecuador Railways have adopted a liquid composed of equal volumes of a 17% solution of nitrate of soda and a 20% solution of arsenious acid.

Ferns.—On hilly pasture lands the most troublesome ferns are the Hay-scented Fern (*Dennstaedtia punctilobula* Moore) and the Brake or Bracken

(*Pteris aquilina L.*). While cutting is probably the best remedy to employ in the case of these two species there may be considerable areas of land too stony for the use of the scythe. The best chemical to use is common salt, 150 pounds in 60 gallons of water per acre. The ferns should be sprayed twice in the season, the first spray being applied before the spores are scattered. While salt has an injurious influence on young clover plants it is on the other hand relished by live stock. This difficulty can be surmounted by sowing clover seed after the second spraying.

Arsenite of soda is equally effective in destroying these ferns but owing to its poisonous nature it is not to be recommended.

Iron sulphate is stated to be ineffective as a remedy. In Scotland a 5% solution of sulphuric acid applied in July and August proved satisfactory as a remedy for bracken and the cost was only one-third of that of cutting.

Red Sorrel or Sheep Sorrel (*Rumex acetosella L.*).—A spray of 20% solution of iron sulphate applied at the rate of 50 to 75 gallons per acre when the plant is in flower has been found effective. The spray does not injure grasses or grain crops but gives a check to clover and alfalfa. These, however, if the weather is moist soon recover.

Orchard heating oil kills this plant as well as all other vegetation. When applied in the form of a fine spray a gallon will cover an area of 400 square feet. A second application may be necessary to finish off the weed.

Lady's Thumb (*Polygonum persicaria* L.)—This weed may be prevented from ripening seeds by spraying with 20% iron sulphate.

Redroot Pigweed (*Amaranthus retroflexus* L.). Iron sulphate 20% should be used before it comes into flower.

Wild Mustard (*Brassica arvensis* Ktze.).—A solution of iron sulphate (130 pounds to every 52 gallons of water per acre) will prove satisfactory and will not injure grain crops. It may be applied with success up to the time of flowering of the mustard.

Instead of iron sulphate, copper sulphate may be used at the rate of 15 pounds in 52 gallons of water per acre.

A solution of 125 pounds of common salt in 50 gallons of water has been found to be as effective as a 20% solution of iron sulphate and will probably cost considerably less.

A 10% solution of sulphuric acid applied at the rate of 60 to 134 gallons per acre will destroy wild mustard.

Wild Radish (*Raphanus raphanistrum* L.).—A 10% solution of sulphuric

acid applied at the rate of 60 to 70 gallons per acre has been used with good effect. It is very important to spray while the plant is quite young.

Shepherd's Purse (*Capsella bursa-pastoris* Medic.).—A 20% solution of iron sulphate will check it.

Field Peppergrass (*Lepidium campestre* R. Br.).—Use 20% iron sulphate.

Wormseed Mustard (*Erysimum cheiranthoides* L.).—Use 20% iron sulphate.

White Cockle (*Lychnis alba* Mill.).—A 30% solution of iron sulphate applied as the plants are coming into bloom has been recommended as a spray for this plant but it is doubtful whether this strength of solution could be safely used in a grain crop.

Purple Cockle (*Lychnis githago* Scop.).—Spraying with iron sulphate will so injure it as to prevent the formation of seeds.

Spurrey (*Spergula arvensis* L.).—Spray with 20% iron sulphate to prevent the formation of seeds.

Mouse-ear Chickweed (*Cerastium vulgatum* L.).—Spray when young with 20% iron sulphate to prevent the formation of seeds.

Chickweed (*Stellaria media* Cyrill).—One thorough application of iron sulphate (15% strength) will kill chickweed if applied when the plant is young.

Blackberry (*Rubus* sp.).—After cutting and burning the dried stems the new growths should be watered or sprayed at intervals with caustic soda (2 lbs. to 4 gallons of water).

A strong solution of common salt or the usual strength of arsenite of soda will prove equally effective.

Vetch (*Vicia* sp.).—A 10% solution of sulphuric acid applied at the rate of 60 to 134 gallons per acre will destroy vetches.

Poison Ivy (*Rhus Toxicodendron* L.).—This plant may be killed by spraying several times during growing season. The first spray should be applied as soon as the leaves are fully unfolded and the second and third at intervals of 10 to 14 days later. The following substances may be used:

1. A strong salt brine made at the rate of 3 pounds of common salt per gallon of water.

2. Arsenite of soda at the rate of ¼ pound per gallon of water.

3. Orchard heating oil.

4. Crude carbolic acid; a 12½% solution applied three or four times during the season at intervals of about 3 weeks.

The advantage of spraying to kill this plant is that it is not necessary to come into contact with the leaves as would be necessary or unavoidable if an attempt were made to cut it.

Wild Carrot (*Daucus Carota* L.).—Spraying with a 10% solution of sulphuric acid applied at the rate of 89 to 134 gallons per acre will check it.

Spreading Dogbane (*Apocynum androsaemifolium* L.).—When growing on waste ground it may be got rid of by spraying with a 5% or stronger solution of caustic soda.

Corn Gromwell (*Lithospermum arvense* L.).—Spray with 20% iron sulphate when the first blossoms appear.

Heal-all (*Prunella vulgaris* L.).—Repeated spraying with 20% iron sulphate will kill it.

Dandelion (*Leontodon taraxacum* L.). There is no doubt whatever that dandelions growing on a lawn can be checked by spraying with a 20 per cent solution of iron sulphate, but the length of time required to kill the dandelion roots absolutely, seems never to have been finally settled. This chemical kills at the same time white clover, but does not appear to do any permanent harm to grass unless in exceptional cases.

Experiments carried out at Guelph, Ont., during three years showed that 90% of the dandelions on a lawn were destroyed by spraying six times during the season. Twenty gallons were used to spray one-eighth of an acre. The results obtained at Geneva, New York State, were not so satisfactory. After spraying a plot six times in the season and again six times in the following season, there were still alive 1085 dandelions on 1000 square feet; one and a half pounds of iron sulphate per gallon of water were used for the first sprayings and two pounds per gallon of water during the second season. Further spraying in the second season had to be discontinued owing to injury to the grass.

Clotbur (*Xanthium canadense* Mill.). It may be killed when three to eight inches high, by spraying with 20% iron sulphate.

Greater Ragweed (*Ambrosia trifida* L.) This weed can be kept from forming seeds by spraying with a 20% solution of iron sulphate or 1½ pounds of sodium arsenite in 52 gallons of water. Spraying should be done when the grain is 8 to 10 inches high.

Common salt, 130 pounds in 52 gallons of water, is also a good spray for this plant.

White Top (*Erigeron annuus* L.) Iron sulphate of the usual strength (20%) appears promising.

Groundsel (*Senecio vulgaris* L.) Several sprayings with 20% iron sulphate will prevent seed-development.

Bachelor's Button or Bluebottle (*Centaurea cyanus* L.). This weed can be checked by spraying with a 10% solution of sulphuric acid applied at the rate of 89 to 134 gallons per acre.

Canada Thistle (*Cirsium arvense* Scop.). This plant when growing in grain crops may be prevented from seeding by spraying with sodium arsenite (2 pounds in 52 gallons of water) or common salt (150 pounds in 52 gallons of water) or iron sulphate (130 pounds in 52 gallons of water).

If sodium arsenite is used it should be applied when the grain is quite young so that the poisonous compound may be all washed off the straw by rain before harvest time.

Summary.

1. As in other parts of the country, weeds are a serious problem in the Province of Quebec.

2. Chemical methods are specially applicable in grain crops and on stony or waste ground that cannot be cultivated.

3. Most useful chemicals for the purpose, strength used, and amount per acre.

4. Results of some experiments at Ottawa.

5. Destroying weeds by heat.

6. List of Quebec weeds that can be checked by this method, 29 species in all.

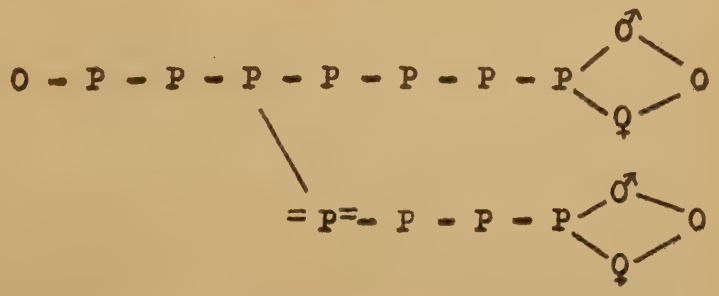
THE MOST COMMON PLANT LICE OR APHIDS.

By W. Lochhead, Macdonald College.

Plant-lice or aphids are gregarious sucking insects, often abundant on many varieties of plants, and doing much injury. Three forms occur: 1. sedentary wingless, viviparous, agamic females; 2. migratory, winged, viviparous, agamic females; 3. sexual males and females—the females oviparous and wingless and the males winged or wingless.

In general, plant-lice are soft-bodied and green, sometimes brown or black. The winged forms have four delicate wings with a few simple veins—the front pair much larger than the hind pair. The sucking beak is three-jointed; the legs and antennae are long and the eyes prominent. In autumn the sexual females deposit eggs that hatch in the spring into females which are often termed "stem-mothers." These produce living females which in turn produce living females, and so on for several generations. As each female produces several young, and these mature in a short time, reproduction is very rapid. When autumn approaches and food supply becomes scarce a brood of winged males and wingless females is produced. The females produce the winter eggs. Sometimes agamic females hibernate.

Reproduction among the aphids may be represented diagramatically as follows:



Where O represents the overwintering egg, P the viviparous agamic wingless form, and = P = the viviparous agamic winged form, and ♂ and ♀ the sexual forms.

There are many species of plant-lice, some feeding on one variety of plant, but many are capable of feeding on two or more varieties. Some feed for a time on one host plant, then migrate to another for the summer, finally returning to the first one in autumn. Some produce abnormal growths called *galls*, such as the

grape phylloxera gall, the cockscomb gall on the elm, the cottonwood gall, the poplar gall, etc.

Most plant-lice excrete a sweet liquid called "honey-dew" or "nectar," which is attractive to ants, bees, wasps and other insects. On account of this honey-dew aphids are often attended by ants who guard them. Forbes has shown that the little brown ant (*Lasius niger*) has domesticated the Corn Root Aphis, which is cared for and controlled in all stages of its development.

Fecundity.

Regarding the powers of reproduction of aphids Webster and Phillips (Bul. 110, U. S. Bur. of Entom.) cite the estimates of Huxley and Buckton. The former estimated that the tenth generation alone of a single rose aphis, were there no deaths, would contain more substance than 500 millions stout men; the latter computed that in 300 days, or 15 generations of 20 each, there would be 20^{15} individuals, equal in weight to 1,638,400,000 men, supposing that 1000 aphids weigh 1 grain and 1 man weighs 2,000,000 grains. Another computer makes the possible number of individuals very much higher, viz., 210^{15}! It is believed that in the case of the spring grain aphis or "green bug" (*Toxoptera graminum*) reproduction would not fall short of the figures given above as the average number of young produced in Indiana by each viviparous female for 1907-8-9 was 28.2. It is conceivable, therefore, how this pest is able to devastate vast areas of grain fields within a few weeks.

Professor Forbes of Illinois (Bulletin 130) also computes the fecundity of the Corn Root Aphis on the basis of a generation of 12 to 15 young in 2 weeks. If all the progeny lived and multiplied at this rate for a season they would reach 9,500,000,000!

In the case of the Green Apple Aphis (*Aphis pomi*) A. C. Baker reports the average reproduction per insect for the entire season as about 40. As the stem-mother becomes mature about 1st May in Virginia, and there are from 9 to 17 generations, or an average of 13, reproduction is very rapid. The potential number of green apple aphids in September from a single stem-mother would be 40^{13} = 671,088,640,000,000,000,000!

J. J. Davis reports for the Oat Aphis (*Aphis avenae*) 15 generations for Indiana with an average of 30 young for each female. The progeny of one stem-mother at the end of the season would be 30^{15}.

The same writer gives for the Pea Aphis (*Macrosiphum pisi*) the average number of young borne by female of 16 consecutive generations as 65. The progeny of a stem-mother at the end of the season would in this case be 65^{16}.

Natural Enemies.

Lady-bird beetles, syrphid maggots, lace-wing larvae, many parasitic hymenoptera, nymphs of tree-crickets, harvest-spiders, birds.

Control.

Spray with kerosene emulsion, whale oil soap solution, tobacco extract, etc.

CHIEF ECONOMIC SPECIES.

Common Cereal and Farm Crop Aphids.

Apple Bud or Oat Aphis (*Aphis avenae Fab.*).—Sometimes called the European Grain Aphis; is often injurious to apple buds and appears before the other apple aphids. Stem-mothers appear early in May and are yellowish-green with three dark lines on back; progeny winged and blackish; migrate to grains and grasses in the second and third generations, winged and wingless generations. Migrate back to apple in September where mating occurs. Males produced on the secondary host and females on the primary host. Beak short and stout: thoracic shield dark; cornicles short and flanged; cornicles, antennae and feet black.

Clover Aphis (*Aphis Bakeri Cowan*).—Sometimes attacks the apple in the middle West. Eggs are laid on the apple; the pink stem-mothers appear early and give rise to green winged and wingless forms. The former migrate to clovers and give rise to several wingless generations. In late autumn the winged forms fly back to the apple and hawthorn where the eggs are laid. Honey-tubes are short.

Corn Leaf Aphis (*Aphis maidis, Fitch*).—Bluish-green, with black legs, antennae and honey-tubes; a row of black dots on each side of back.

Corn Root Aphis (*Aphis maidi-radicis Forb.*)—Bluish-green lice on the roots of corn, smartweed and other weeds; attended by brown ant (*Lasius niger*). (See Farmers' Bul. 891, U.S. Dept. Ag.).

Spring Grain Aphis or Green Bug (*Toxoptera graminum Rond*).—Infests cereals in spring; wingless form yellowish-green, with faint dark line along back; eyes black. Winged form larger, with darker thorax. Migrates to other regions and to grasses. Parasitized by *Lysiphlebus tritici.*

Western Grain Aphis (*Brachycolus tritici Gillette*).—Is injurious to winter wheat in Montana.

English Grain Aphis (*Macrosiphum granarium Kirby*).—Occurs on wheat, barley and the grasses, *Agrostis, Bromus, Dactylis, Poa* and *Phleum and Cat-tail.* Widely distributed in the U.S.

2. Common Fruit Aphids.

Apple Bud or Oat Aphis (*Aphis avenae Fab.*).—See above.

Green Apple Aphis (*Aphis mali Fab.* = *A. pomi DeG.*)—This aphis collects usually on the tips of tender shoots, on the under surface of the leaves, and when abundant attacks the developing fruit. Winters on twigs as black shining eggs which hatch just before leaf buds open; 1-12th inch long, pear-shaped; bright green; black, slender cornicles; inhabits the apple throughout the season; winged females occur during summer. Causes curling of the leaves to some extent, those of young trees suffering most. Several (10-15) generations in a season, and each generation shorter than three weeks, and each mother produces 70 young.

Rosy Apple Aphis (*Aphis sorbi Kalt* = *A. malifoliae Fitch* = *A. pyri Boyer*)—This shade-loving aphis collects around the flower buds, the developing fruits and on the under side of the leaves. It causes nearly all the curling of the leaves and the "cluster-apples." Larger than preceding; 1-9th inch long. Wingless females blue; honey-tubes yellow tipped with black, long and tapering; body covered with a powdery substance. Winged females with black thorax and red abdomen, honey-tubes long and black. Two small tubercles at end of abdomen; the late winged forms are migrants and have a black patch on abdomen, black bands across last segments of abdomen, and black spots on sides. Egg-laying females lemon-yellow, mate with migrant winged males. In this species also the males are produced on the secondary and the females on the primary host. After the third summer agamic generations this species deserts the apple for the plantain, but returns in autumn.

(Consult "Apple Tree Insects of Maine," and Circ. 81, Bur. Ent. U.S. Dep. Agr).

Cherry Aphis, (*Myzus cerasi Fab.*)—Shining black; long, slender honey tubes; antennae not as long as body, smoky, cauda pointed, black and hirsute. Is a pest of the cherry. Migrates to wild pepper grass.

Clover Aphis (*Aphis Bakeri Cowan*)—See above.

Green Peach Aphis (*Myzus persicae Sulz*).—This general feeder is our most common greenhouse species. Under glass it reproduces viviparously from year to year. At first the young lice are pink, but next generation is bright green. Migration in third generation to garden crops (where it has been known as *Rhopalosiphum dianthi Schr.*) returning in autumn to peach.

Currant Plant Louse (*Myzus ribis L.*)—A small yellowish plant-louse causing a curling and blistering of the leaves of currants with red discoloration of the upper surface. Wingless female light green and mottled; body covered with capitate hairs, and with two rows of spots on mid-dorsal surface. Winged forms

darker and abdomen crossed by several bands. Migrates to *Stachys and Galeopsis* (*Gillette*).

Hop Plant Louse (*Phorodon humuli Schrank*).—Migrates from plum to hop in the third generation; yellowish-green, with a prominent tubercle on head at base of each antenna, and another smaller tubercle on the base of each antenna.

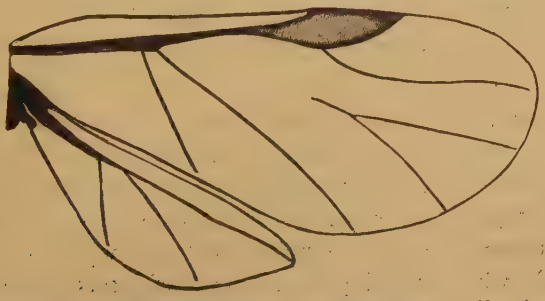
Winged and apterous females of the plum and hop louse, *Phorodon humuli* Schrank. (After Riley.)

APPLE WOOLLY APHIS

(*Consult Bul. 256 Maine Agr. Expt. Stn., 1916, and Report 101, U.S. Bureau of Entomology, by A. C. Baker.*)

This native woolly aphis is frequently injurious to many varieties of apple trees, causing deformations both on the stems and leaves and on the roots. It occurs also on pear, hawthorn and mountain ash, and passes part of its life on the elm. The injury to the roots consists in the formation of hard fibrous enlargements resembling knots or clubs, often causing the death of the affected part. Nursery stock is liable to infestation and severe injury. The injury to the branches is not so serious, but in cases of severe infestation it causes stunted growth and yellowing of the leaves. Colonies often collect at the axils of leaves, on watersprouts, and at abrasions and wounds.

The common form seen on roots and limbs is wingless, 1-10 inch long, reddish-brown, and covered with a woolly waxy excretion.



Woolly Aphis of elm and apple (*Schizoneura lanigera*) (*Americana* in part). Venation of wing of spring migrant from elm rosette. (After Patch).

The life history of the trunk forms is as follows:—

Some winter near the base of the apple tree as immature nymphs: but those in the elm as eggs in crevices of the bark. The hibernating nymphs on the apple migrate to the branches in early spring, and a succession of parthenogenetic generations of apterous viviparous females appears throughout the season. From the eggs on the elm hatch out apterous viviparous stem-mothers in early spring about May 15th; the second generation is also apterous viviparous, but the third is winged and migrates to the apple, hawthorn and mountain ash where three generations are developed, two being apterous, and the third part apterous and part winged. The winged form migrates back to the elm, and produces the wingless sexual forms. Each female lays one large yellow egg which winters on the tree. The wingless forms remaining on the apple give rise to another generation which winters over as immature nymphs.

The injury to the elm leaves is characteristic—the formation of terminal leaf clusters or rosettes. *S. americana* produces leaf-curl.

The winged forms are nearly black, the abdomen being rusty brown, the wings are clear and the antennae have annulations and are 6-jointed. The sexual forms are wingless, beakless, smaller than the agamic forms; the female, 1-20 inch long, reddish yellow, is larger than the olive yellow male; the antennae are 5-jointed, and without annulations as in other apterous forms. The root colonies ordinarily remain underground throughout the year, and do less injury northward.

Parasites.—Aphelinus mali, a chalcid; *Pipiza radicum*, a syrphid; lady bird beetles.

Control.—Spray thoroughly the aerial forms with kerosene emulsion, soap solution or tobacco decoction; dip roots or suspected nursery stock in same solution or fumigate with HCN; add tobacco dust to the soil.

Black Peach Aphis (*Aphis persicae-niger Er. Sm.*)—Black; lives on rose twigs and leaves. No migration. Of no economic importance in Ontario.

Mealy Plum Louse (*Hyalopterus arundinis Fab.*)—Has long narrow light green body with three longitudinal stripes; covered with a mealy powder; honey-tubes short and thick; winged females migrate in June to grasses and cat-tail and return in autumn.

Variable Currant Aphis (*Aphis varians Patch*).—Infests currants, gooseberries and flowering currants, causing curling of the leaves. The winged summer forms migrate to some unknown host, and return in the fall. The eggs are deposited on the twigs. The stem-mother is purplish-green with white honey tubes. The winged form has a black head and body, with a dark green abdomen marked with black, while the wingless form is dark green, tan or dark brown.

Green Gooseberry Aphis (*Aphis Sanborni Patch*).—Green; honey-tubes white.

Grape Phylloxera (*Phylloxera vitifoliae Fitch = vastatrix Planchon*).—Four forms are recognized: 1. Wingless leaf-gall form; 2. Wingless root form; 3. Winged form; 4. Sexual form.

1. Adult leaf-gall form is a wingless female, plump, orange-yellow. Fills gall with many yellow eggs which hatch in 8 days into females. Several generations during summer. The feeding puncture stimulates the growth of the leaf tissue so that a hollow gall is produced, opening on the upper surface.

2. Root form similar to that on leaf; often derived from leaf form; several generations in a season; yellowish and wingless, and forms nodules which break down and decay, often destroying the root. Yellowish oval eggs are laid on the roots. Larvae moult three times. Leaf-galls are most common on American grapes while root-galls are most common on European grapes.

3. Some of the root forms in late summer develop elongate long-legged winged females that fly to neighboring vines and lay 2-4 eggs beneath loose bark.

4. These eggs are of two sizes—the smaller producing males, the larger sexual females. These are wingless and minute. Each female lays one large egg from which hatch the following spring the leaf and root forms.

Not destructive on sandy soils.

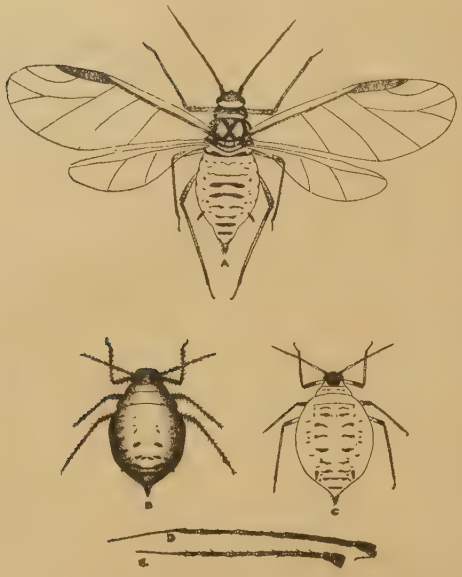
Control.—Spray in early spring with lime sulphur; use American varieties as stock.

3. Common Garden Aphids.

Cabbage or Turnip Plant Louse (*Aphis brassicae L.*)—Often abundant on the under surface of leaves of cabbages and turnips, and very destructive in warm dry weather. A greenish, soft, pear-shaped insect covered with a whitish bloom. Mature forms have black head and eyes and dark cornicles; nymphs are pale green with black legs and antennae. Parasite, *Aphidius rapae*, a braconid.

Aphis pseudobrassicae Davis.—Also occurs on turnip, radish, cabbage, grape, mustard, etc. and is often mistaken for *A. brassicae.*

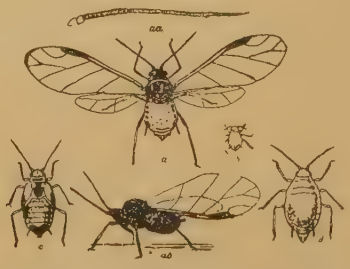
Melon Plant-louse (*Aphis gossypii Glov*).—Occurs on the under surfaces of the leaves of melon, cucumber, squash etc., and also on other crops and weeds. Winter eggs have been found on purslane and strawberry. A blackish-green insect. Apterous females with legs and antennae whitish, cornicles black and short; winged forms with a row of black spots on sides of abdomen, and spots on head and thorax.



Cabbage Louse (*Aphis brassicae* Linn.). A, winged female; B and C, apterous females; D, Antenna of; A E, antenna of B and C.

Bean Aphis (*Aphis rumicis L.*)—Occurs on the tips of horse and broad beans at time of flowering. When the lice are abundant the plants assume a sooty sickly appearance. Also on apple, dahlia, dock, shepherd's purse, pigweed, snowball and burning bush. This aphis is slaty blue or black, with white bands on the legs and often with waxy tufts. Called also the "black fly," "collier" and "black dolphin."

Strawberry Root Louse (*Aphis forbesi Weed*).—Bluish-green, on roots of strawberry; occurs also on leaves. Eggs laid on stems and leaves. Ants carry lice to roots. Of no economic importance in Ontario.



Aphis gossypii; a, winged female; b, young nymph or larva; c, last stage of nymph; d, wingless female; all enlarged. (From Chittenden.)

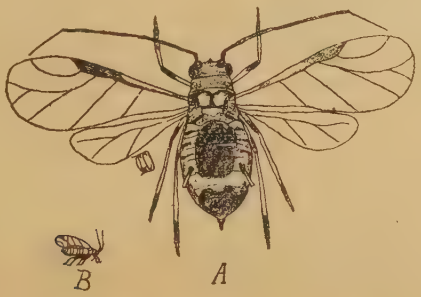
Pea Plant Louse (*Macrosiphum pisi Kalt*).—Green; eyes red; legs long; migrates in August to clover fields where eggs are laid and first spring generation feeds.

Parasites—*Aphidius fletcheri Ash.*, *Megorismus fletcheri Crwd*, a chalcid.

Potato Plant Louse (*Macrosiphum solanifolli Ashmead*).—Green or pink; migrates to the rose, where winter is spent. Feeds on a large number of plants.

Green Rose Aphis (*Macrosiphum rosae Linn.*)—A large pale green aphis with dark antennae and the cornicles long and black. Occurs on roses.

Black Chrysanthemum Aphis (*Macrosiphum sanborni Gill.*)—Occurs on chrysanthemums in greenhouses. A brownish-black pyriform plant-louse.



Celery Aphis, enlarged, after G. C. Davis.

4. Common Shade and Forest Tree Aphids.

Negundo Plant Louse (*Chaitophorus negundinis Thos.*)—A serious pest of the ash-leaved or Manitoba maple in the west. Infested trees soon become covered with honey-dew in which a sooty fungus develops.

Woolly Apple Aphis (*Schizoneura lanigera* or *Americana*).—See above.

The Poplar Leaf Gall Louse (*Pemphigus populicaulis Fitch*).—Produces a deformity at the junction of petiole and blade of Cottonwood and Aspen.

Alder Blight (*Pemphigus tessellatus Fitch*).—A woolly aphid, occurs on branches of alder. Winged forms migrate to the maple.

Beech Tree Blight (*Pemphigus imbricator Fitch*).—A similar form on the twigs and leaves of beech.

Sitka Spruce Gall Aphis (*Chermes cooleyi Gillette*), *Western Hemlock Woolly Aphis* (*Chermes funitectis Dreyfus*), *and Sitka Spruce Green Aphis* (*Aphis abietina Walk*) are important economic forms on the Pacific Coast of British Columbia.

Spruce Gall Aphis (*Chermes abietis Chol.*)—Abundant locally on white and Norway spruces, producing pineapple-like galls at base of terminal shoots. Each gall, ¾ inch long, contains about 50 cells each holding from 8 to 12 nymphs. The life-cycle is briefly as follows:—

"Galls open about mid-August and fully grown pupae emerge and molt within a few hours becoming the winged form which deposits a cluster of 40 to 50 yellow eggs on a spruce needle. The eggs are extruded from the abdomen but the parent chermes remains over them until dislodged after her death by wind or rain. The winged form often oviposits near the gall from which it emerges. A different species of host plant is never sought by this Chermes. In about two weeks the young "stem-mothers" hatch from these eggs and seek a protecting crevice is the surface of the spruce bud where they can spend the winter. These wingless forms develop in the spring and become full grown about the last of May when they lay a cluster of 140 or more eggs. From these eggs hatch the young that inhabit the gall and are known as the "gall generation" with which we started the cycle." (Patch).

Spruce Gall Aphid (*Chermes similis Gill.*)—(Consult Bul. 173, Maine Agr. Exp. Stn.).

Abundant locally on black, red, white and Norway spruces, producing loose terminal galls and scraggly deformed twigs. The galls open about 1st July and the winged flocculent migrants oviposit on spruce.

Control.

Spray in early spring while trees are dormant with whale oil soap (1 lb. to 2 gal. water). Black Leaf 40 (1 to 800) added to soap (1 lb. to 4 gal. water).

Pine Bark Aphid. (*Chermes pinicorticis Fitch*).—A common enemy of cultivated pines, appearing as flocculent white masses upon the green bark of the more tender parts.

Control: Spray in late April or May with fish oil soap or kerosene emulsion.

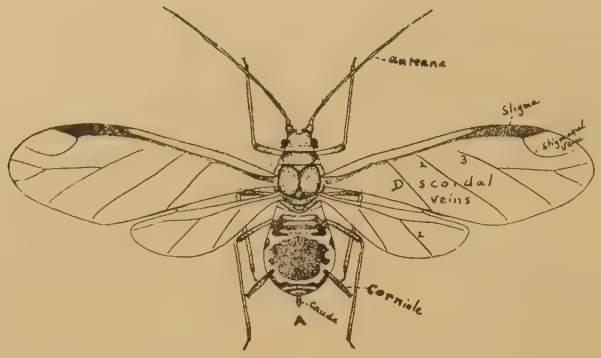
DOUBLE-HOST APHIDS.

Following is a partial list of double-host Aphids:—

Chermes abieticolens on spruce	= Chermes pinifoliae on white pine.
Pemphigus tesselatus Fitch on alder	= Pemphigus acerifoliae Riley on maple.
Pemphigus balsamiferae on cottonwood	= Pemphigus betae on beets.
Eriosoma pyricola on pear	= Eriosoma pyricola on elm.
Eriosoma lanigera on apple	= Eriosoma americana in part on elm.
Eriosoma americana on plum	= Eriosoma americana on Juneberry.
Eriosoma ulmi on English Elm	= Eriosoma fodiens on currant.
Hyalopterus arundinis on plum	= H. arundinis on reed grass, cat-tail.
Phorodon humuli on plum	= P. humuli on hop.
Aphis avenae on apple	= A. avenae on oats, cat-tail etc.
Aphis sorbi on apple	= A. sorbi on plantain.
Aphis viburnicola on snowball	=
Aphis pruni on plum	= Aphis cardui on thistle.
Aphis nerii on oleander	= A. lutescens on milkweed.
Aphis bakeri apple and hawthorn	= Aphis bakeri on clover.
Aphis brevis on apple and hawthorn	= Aphis brevis on clover.
Aphis enonymi on snowball and burning bush.	= Aphis rumictis on bean and dahlia.
Macrosiphum illinoiensis on Viburnum prunifoiae.	= M. illinoiensis on grape.
Macrosiphum solanifolii on rose	= M. solanifolii on potato.
Macrosiphum granarium on grains, rose etc.	= M. granarium on cat-tail.
Aphis prunorum Dob. on plum	= Rhopalosiphum nymphaeae on Nymphaea, Alisma, Sagittaria, Typha.
Rhopalosiphum ribis on Ribes	= R. lactucae on Sonchus.
Rhopalosiphum caprea on willow	= R. capreae on Umbellife rae.
Myzus ribis on Ribes	= M. galeopsidis on galeopsis.
Myzus cerrasi on cherry	= M. cerasi on Lepidium.
Rhopalosiphum pasticaceae on Lonicera	= R. pastinaceae on Pastinaca.
Hormaphis hamamelidis Fitch on witch hazel.	= Hormaphis hamamelidis on birch.
Hamamelistes spinosus Shimer on witch hazel.	= Hamamelistes spinosus Shim on birch.
Tetraneura graminis on Ulmus	= T. graminis on Leersia.
Thecabius populiconduplifolius on poplar.	= T. californicus on Ranunculus.

Chermes floccus on white pine..... =Chermes floccus on red and black spruce.

Chermes cooleyi on Blue and Engelmann =Chermes cooleyi on Douglas fir.
spruces.



The Green Peach Aphis (*Myzus persicae* Sulz.) showing also the venation of the wings and the location of the antennae, cornicles and cauda. (After Essig.)

APHIDIDAE (PLANT LICE OR APHIDS)

Chief Economic Genera.

A.—Front wings with three discoidal veins; antennae generally 6-7 jointed.
B.—Third discoidal vein of front wings twice forked (exception Toxoptera).
C.—Cauda long, antennae on distinct frontal tubercles.
D.—Third discoidal vein once branched.—*Toxoptera.*
DD.—Third discoidal twice branched.
E.—Cornicles cylindrical or slightly tapering.
F.—Frontal tubercules strongly gibbous on the inner side.—*Myzus.*
FF.—Frontal tubercles with a long tooth on the inner side.—*Phorodon.*
FFF.—Frontal tubercles not or only slightly gibbous.—*Macrosiphum.*
EE.—Cornicles clavate at the tips.—*Rhopalosiphum.*
CC.—Cauda short and conical. Distinct frontal tubercles absent.—
D.—Cornicles clavate.—*Hyadaphis* (*Siphocoryne*).
DD.—Cornicles not clavate.
E.—Cornicles moderately long, longer than cauda, cylindrical. *Aphis.*

EE.—Cornicles very short, shorter than cauda, slightly constricted at base.—*Hyalopteris.*

CCC.—Cauda very short and rounded.

D.—Antennae with five joints.—*Lachnus.*

DD.—Antennae with six joints.

E.—Antennae longer than body, never hairy.—*Myzocallis.*

EE.—Antennae shorter than body and hairy.

F.—Cornicles swollen or vasiform, cauda broadly rounded.—*Melanoxantherium.*

FF.—Cornicles tuberculate, cauda knobbed.—*Chaitophorus.*

BB.—Third discoidal vein of front wings once forked or simple.

C.—Third discoidal vein simple.

D.—Hind wings with two discoidal veins.—*Pemphigus.*

DD.—Hind wings with but one discoidal vein.

E. Antennae 6-jointed.—*Tetraneura.*

EE.—Antennae 5-jointed.—*Hamamelistes.*

CC.—Third discoidal vein forked.

D.—Hind wings with two discoidal veins.—*Eriosoma* (*Schizoneura*).

DD.—Hind wings with one discoidal vein.—*Colopha.*

AA.—Front wings with two discoidal veins; antennae never more than 5-jointed.

B.—Antennae 5-jointed.—*Chermes.*

BB.—Antennae 3-jointed.—*Phylloxera.*

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1914

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